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THE SIGNIFICANCE OF PLEISTOCENE MOLLUSKS[1]

IN the investigation of natural problems the most conspicuous or bulkiest character does not always furnish the most convincing evidence. We readily see the mass of diatomaceous earth, but we do not understand its gritty quality, nor can we appreciate its origin until we have studied the minute, individually almost negligible frustules which make it up; sandstones or limestones may form great cliffs, but it requires the comparatively insignificant fossil to finally reveal the origin and the place of the rock. Similarly, in the study of the Pleistocene we encounter gross features which have their value—we find variously comminuted and diversely arranged materials in great bulk; we find topographic and physiographic characters on a large scale; yet the best evidence which we have concerning the conditions under which certain parts of the Pleistocene formations were deposited is furnished by the fossils which usually form a small and not always conspicuous part of the deposits.

Both plant and animal fossils have been found in the various subdivisions of the Pleistocene. The former consist chiefly of the leaves and wood of gymnospermous and angiospermous trees and shrubs, mosses and diatoms; the latter of some insects, a conspicuous, though limited, mammalian fauna, and the mollusks which form the most widely distributed and most universally present group of all.

[1] Address of the vice-president and chairman of Section E—Geology and Geography—American Association for the Advancement of Science, Cleveland, 1912.

The plant remains and insects are too few and too widely scattered to form a satisfactory measure of conditions; the mammalian fauna is but little better in this respect and, moreover, consists of species which are for the most part extinct, and whose exact habits are not known; but the mollusks are not only most widely distributed in the Pleistocene deposits, but belong practically without exception to species now living whose habits may be very accurately determined. For these reasons the mollusks form the most important and most significant group of Pleistocene fossils.

Aside from the marine species of the coastal formations, which will not be here considered, the Pleistocene and modern species of mollusks naturally group into three rather well-defined divisions according to habits:

1. *Fluviatile species,* inhabiting perennial streams and lakes. These are chiefly bivalves, especially larger *Unionidæ,* and operculate gill-bearing gasteropods. A few aquatic pulmonates, like *Lymnæa emarginata* and *Planorbis truncatus,* also prefer larger bodies of water.

2. *Pond species,* inhabiting ponds, bogs and borders of smaller streams, which are likely to become dry during a part of the summer, and also the shallow swampy borders of larger bodies of water. These species are chiefly aquatic pulmonates, with a few smaller bivalves, especially of the genus *Pisidium.*

3. *Terrestrial species,* living among plants, sometimes on the bark of trees, often under leaves, sticks and stones. Among them are two operculate prosobranchs, closely related to aquatic species of the first group, but the great majority are terrestrial pulmonates. A few species, such as *Succinea retusa, Zonitoides nitidus, Vertigo ovata* and *Carychium exiguum,* naturally group with the terrestrial pulmonates, but they are commonly found in wet places, and sometimes live in the water for a time, behaving then like the aquatic pulmonates of the pond group.

The members of the pond and terrestrial groups are closely associated with plants which they require for shelter and in most cases for food. The terrestrial forms are most abundant on forested areas, but certain species, such as *Succinea grosvenorii, Cochlicopa lubrica, Vallonia gracilicosta,* etc., also extend into more open territory.

While all the terrestrial species require some moisture for activity, the amount which may be found at times under a leaf or stick, or among plants on a dewy morning, or after a rain, is entirely sufficient for the purpose. This supply of moisture is irregularly intermittent, and the mollusks remain inactive while waiting for a return of favorable conditions. Sometimes they protect themselves by a mucous epiphragm, or they creep under leaves or sticks, or burrow into the soil. Long-protracted dry seasons are fatal to many of them.

The fossil mollusks are distributed through a variety of formations. Those of the Aftonian, the Don beds, the Florencia formation and similar older Pleistocene deposits, like those of the more modern alluvial beds, present the fluviatile and pond facies in the main, though there is often a strong admixture of terrestrial forms. Those of the loesses are terrestrial in the main, with comparatively rare additions of pond types and a total absence of fluviatile forms.

Practically all of the species found in the various Pleistocene formations are living upon the continent to-day. Such exceptions as *Oreohelix ioensis* from the loess and species of *Pisidium* and *Lymnæa* recently described from indefinite alluvium,

do not materially affect the truth of this statement, for these may be mere races, or a more critical study of these difficult genera may show that the apparently extinct forms are living to-day. They are certainly very closely related to existing forms, and suggest no peculiar set of conditions.

Because of the practical identity of the fossil and certain modern molluscan faunas important conclusions may be drawn concerning the conditions which existed at the time of the deposition of the fossiliferous deposits.

The first question which naturally comes to the mind of the student of Pleistocene geology in this connection is this: Could these mollusks have lived under glacial or near-glacial conditions? As in so many other cases, the measure of the past must here be sought in the present. Unfortunately, we do not anywhere have conditions which exactly parallel those which existed in the interior of our continent during the several advances of the ice-sheets. The climate of Alaska is so materially affected by warm ocean currents that no fair basis for comparison can here be established. The Antarctic region presents no partly glaciated continents, and comparisons are here impossible. Perhaps Greenland offers the nearest parallel, but even here in the study of plant and animal life we have to deal with a narrow coastal strip the climate of which is manifestly affected by the proximity of the sea.

From this narrow strip Möller reported, in 1842, four species of terrestrial mollusks (a *Vitrea,* a *Pupa,* a *Vitrina* and a *Succinea*) and three species of pond snails, two of the genus *Lymnæa* and one of *Planorbis.* These species were all represented by few widely scattered individuals, and constitute a very scant fauna. Nowhere in all the barren ground belt bordering the Arctic ice have such combinations of species been observed as we find in the various Pleistocene deposits of our country. The latter suggest rather a region very similar to the present northern part of our country, in the main, with relationship in some of the deposits with the fauna of the southern states, and in others some affinity with that of the coniferous belt to the north.

Our present knowledge of the habits and distribution of the fossil and modern mollusks forces the conclusion that the deposits containing these species are interglacial or post-glacial, and that they were formed during a period of mild climate.

The second important question concerns the immediate conditions under which the various deposits were formed. To answer this question intelligently on the basis of the molluscan fauna we must understand the habits of the mollusks as well as the conditions under which the land and freshwater forms may mingle.

For purposes of comparison your essayist has made extensive studies of the habits of the modern molluscan fauna of the Mississippi Valley, and has compared large series of shells thrown up along the shores of larger streams and their smaller tributaries, as well as ponds and lakes, with the shells obtained from various Pleistocene deposits and from more modern alluvium, and nowhere has he found any evidence that the conditions under which the Pleistocene deposits were formed were materially different from those which are in operation in the same region to-day.

All of the Pleistocene deposits, with the exception of the loesses and certain buried sand dunes, are aquatic, and a comparison of their molluscan contents shows the same peculiarities and the same variations as are presented by the modern alluvial and water-drifted fauna.

Some of these points of similarity are brought out by a comparison of the mollusks from various deposits. Thus the Aftonian beds of Harrison and Monona counties, Iowa, have yielded 28 aquatic species and 9 terrestrial species;[2] the Don beds, 42 species, of which all but two are aquatic;[3] the Florencia formation, 30 aquatic and swamp species and 19 terrestrial species;[4] the buried silt in the Illinois Central cut in Sioux Falls, 14 aquatic and 2 terrestrial species, one of the latter doubtfully belonging to the deposit;[5] the more modern river alluvium of Harrison County yielded 18 aquatic and swamp species and 19 terrestrial species;[6] the lacustrine alluvium of West Lake Okoboji exposed by recent canal excavations, yielded 27 aquatic and swamp species, and 1 terrestrial species; modern drift along the Big Sioux River opposite Canton, South Dakota, contained 18 aquatic and 5 terrestrial species; similar drifted material along the Missouri River at Rulo, Nebraska, showed 12 pond and swamp species, and 15 terrestrial species; and drifted material on the north shore of Miller's Bay, West Lake Okoboji, Iowa, contained 14 aquatic and marsh species and 14 terrestrial species.

These lists indicate that terrestrial mollusks are not uncommon in the various alluvial deposits. It should be remembered, however, that as a rule the terrestrial species are represented by very few individuals which accidentally drifted in from adjacent land surfaces, while the aquatic species belonging to the genera *Sphærium, Pisidium, Campeloma, Valvata, Amnicola,* the larger species of *Lymnæa, Physa, Planorbis, Segmentina* and *Ancylus* occur in larger numbers.

In those case in which larger numbers of terrestrial forms occur, as in the Miller's Bay and Rulo lists, they may be traced to nearby wooded bluffs, and it is evident that the relatively large number of terrestrial forms in the Harrison County alluvium and the Florencia formation may be traced to the same source.

It is evident that the shells do not drift far in any case. The Missouri River contains few aquatic mollusks, but its smaller tributaries usually show an abundance of them. Yet rarely are fluviatile shells found in modern river drift along the Missouri, and the aquatic species are of the pond type prevailing in small ponds along the main river, as is shown in the Rulo list. Shells of terrestrial species which are limited in their distribution are also seldom found at any distance from their habitat. This is strikingly illustrated by *Helicina occulta,* which is now restricted to limited and widely separated areas. Thus at Iowa City a colony inhabits a half-acre of wooded bluff, and in thirty years your essayist has found but one fresh shell along the creek at the foot of the slope, and none along the nearby river to which the creek is tributary.

A recently discovered colony of this species in a similar situation along the Cedar River above Cedar Rapids, Iowa,[7] gives like results. Various students of mollusks have collected in this region, yet no fresh shells of this species were ever observed in the drifted material along the Cedar River. The Miller's Bay list shows that 14 species of terrestrial shells were carried across the bay from the wooded southern shore, yet repeated dredging in the bay has brought

[2] See Iowa Geol. Survey, Vol. XX., 1910, pp. 395–6.

[3] *Journal of Geology,* Vol. IX., 1901, pp. 291–2.

[4] *Am. Jour. of Science,* 4th series, Vol. IV., 1897, p. 96.

[5] For description of this cut see *Bull. of the Geol. Soc. of Am.,* Vol. 23, 1912, pp. 141–3.

[6] Iowa Geol. Survey, *ibid.*

[7] By Mr. E. G. Grissel, of Cedar Rapids, Iowa.

to light only four of these species, represented by very few individuals, which had dropped to the bottom of the bay. Terrestrial shells which drift into water are soon cast ashore.

Nearby wooded slopes frequently contribute terrestrial shells to ponds and streams, but the latter invariably supply a relatively large number of shells of aquatic species.

It is also noticeable that such species as *Zonitoides nitidus* and *Succinea retusa*, of low grounds, and *Helicodiscus parallelus*, *Vitrea hammonis*, *Bifidaria armifera*, *B. contracta*, *B. pentodon*, *Zonitoides arboreus* and *Z. minusculus*, which are common on timbered alluvial flats and which occur so frequently in alluvium and modern river drift, are relatively very rare in terrestrial deposits like the loesses.

Another method by which terrestrial shells sometimes find their way into alluvial deposits has been observed where shallow ponds become dry during the summer. These ponds usually contain aquatic pulmonates, and their shells remain in the alluvium of the pond. Terrestrial species then creep out over the exposed surfaces, not infrequently leaving their shells to mingle with those of the pond species. The subsequent flooding of the pond results in the inclusion of both types in the alluvium of the pond. In the alluvium of one pond of this type between the Lakes Okoboji, Iowa, 12 aquatic and 5 terrestrial species were found, the latter being represented by few individuals.

Still another method by which aquatic species may be buried at altitudes higher than the level of the free water surface may be observed in seepy places fed by permanent springs. Such spots are not uncommon even on higher slopes and they frequently contain aquatic species belonging to the genera *Pisidium*, *Lymnæa* and *Physa*, probably introduced by small wading birds. Terrestrial species from nearby surfaces may creep out or be carried into the bog and the shells of both will then be mingled in the deposit of the bog. In one of these small bogs near Council Bluffs, Iowa, located at an altitude fully twenty feet above the high-water level of the Missouri River and closely surrounded by a forest, 5 terrestrial and 1 aquatic (*Pisidium*) species were collected, while in another on a prairie slope near West Lake Okoboji 3 aquatic species belonging to the genera *Pisidium*, *Lymnæa* and *Physa* were collected at an altitude of more than forty feet above the lake. In the latter case the surrounding prairie surfaces contributed no terrestrial species.

And finally individual specimens of aquatic species of mollusks may be carried to uplands by aquatic birds and insects, where their shells may ultimately be included in terrestrial deposits.

In order that the value of these molluscan faunas may be properly measured it is necessary that they be taken collectively. A single terrestrial shell does not make a land deposit, neither does a single aquatic shell make a water deposit. In water deposits aquatic shells always form a conspicuous part of the fauna, even though locally they may not predominate. In subaerial deposits aquatic shells may occur, but they are rare and local, and the dominant types are terrestrial. Strictly terrestrial Pleistocene deposits are of two types: buried sand dunes and the loesses. Buried sand dunes are not uncommon in the upper Mississippi Valley, excellent illustrations being found near Gladstone, Illinois; north of Iowa City, Iowa; at Hooper and West Point, Nebraska, and at other points. Neither buried nor surface dunes contain shells so far as observed.

The loesses are much more satisfactory

for our purposes, because they frequently contain fossils and offer by far the best opportunity for the study of Pleistocene terrestrial mollusks. In these deposits terrestrial forms vastly predominate, and fluviatile forms are wholly wanting. So much has been written on this feature of the subject that only reiteration is here possible.

Fresh-water shells in the loess are very few. They belong to species which inhabit small ponds and boggy places. They are not of the types found in streams and lakes. They are local in distribution, and in a number of cases clearly associated with buried ponds. Ponds are not rare in high places in loess regions. They frequently contain the smaller *Lymnæa,* etc., which are sometimes found in the loess, aquatic birds and insects probably being responsible for their introduction. Such ponds, if buried by subsequent depositions of loess, would present exactly the conditions under which aquatic shells are usually found in the loess. The vastly predominating forms are terrestrial—*upland terrestrial at that.* Some have become extinct in the loess region, but occur westward and southwestward in the drier part of the continent. Such are *Pupa muscorum, P. blandi, Sphyradium edentulum* var. *alticola, Pyramidula shimekii* and *Oreohelix iowensis.* Others like *Succinea grosvenorii* and *Vallonia gracillicorta* are still found in the loess region, but they prefer dry, often open grounds. The land species which prefer wet grounds are conspicuously absent from the loess.

The usual type of the fauna of the northerly loess is well illustrated by the fossil and modern fauna of King Hill, South St. Joseph, Missouri. This elevation rises 225 feet above the Missouri River bottoms and is capped by a thick bed of yellow loess which is quite fossiliferous to the very summit. The northeastern slope is covered more or less with low shrubs and stunted trees from twenty to eighty feet below the summit, merging below into a native grove. The loess at the summit yielded nineteen terrestrial species. Of these seven were also found living on the shrub-covered northeast surface in a relatively very dry habitat. With the latter were associated six additional terrestrial species which were not found in the summit loess, but all of which are known from the loess of the Missouri Valley. The nineteen fossil and thirteen modern species are all strictly terrestrial and the six species which are common to both well characterize the habitat of the entire fauna. A more careful examination of both the loess and modern surface faunas near the summit of King Hill would no doubt reveal a larger number of species common to both.

The fossil mollusks do not enable us to determine the age of any of the Pleistocene formations. The fossils of the Aftonian are not sufficiently distinct from those of modern alluvium to permit the drawing any conclusion other than that the conditions of deposition were much the same. They do not enable us to distinguish between the loesses, for the fossils of the gray and the yellow loesses are, in larger series, essentially the same. But they give us an excellent measure of the conditions which prevailed at the time of the deposition of the various fossil-bearing Pleistocene strata.

The fact that several ice sheets advanced into the upper Mississippi Valley has been well established. The advance and retreat of these several ice sheets were in all probability very slow, resulting in a gradual transition to and from a glacial climate. This suggested the desirability of search for evidence of such gradual transition among the mollusks of the several interglacial periods. But no such evidence has

as yet been found, and it is evident that the fossiliferous Pleistocene deposits were formed after the interglacial and postglacial conditions had been fully established.

In no known Pleistocene deposit is there a vertical gradation of species which can be accounted for on climatic grounds.

The variation in horizontal distribution does not in any case indicate a climate of greater severity than that which exists in the same region to-day. The determinable deposits containing fluviatile and other aquatic shells are of such limited extent north and south, and, moreover, the species which they contain are now so widely distributed that they present no evidence of climatic variation.

The terrestrial mollusks which are found in the Pleistocene deposits are also now of very wide distribution and the variation which they exhibit in species, form and size is not at all determined by latitude, but rather by the edaphic conditions under which the forms existed. In both cases the species are those of modern faunas whose habits are well known.

Variations in the Pleistocene fauna are nowhere better illustrated than in the loess, which has a wide distribution both north and south, and east and west, in the Mississippi Valley. If we begin in the northwestern part of the loess area in Nebraska and western Iowa, we find that the dominant species in the loess are *Pupa muscorum, P. blandi, Pyramidula shimeki, Succinea grosvenorii, Oreohelix ioensis, Vallonia gracilicosta, Bifidaria procera, Sphyradium edentulum alticola.* These species all belong to a fauna characteristic of the dry western regions, *Pupa muscorum* alone passing by a wide detour northward to the northeastern part of the country. Other species belonging to more easterly faunas appear, as a rule, in smaller numbers. Southward along the Missouri River, as in northwestern Missouri, larger forms, such as *Circinaria concava, Pyramidula alternata* and *Polygyra multilineata,* more characteristic of eastern and southeastern faunas, begin to appear in larger numbers. The change southward along the Mississippi is even more striking. In the northerly deposits along the Mississippi *Helieina oculta, Pyramidula striatella, Succinia ovalis* and *S. avara* are among the most common species. *Pupa decora* is also abundant in both northern and northwestern loess, and while it is largely a boreal species, like *Pupa muscorum,* it extends along the western mountains well into our dry western region.

Southward along the Mississippi the loess molluscan fauna changes in essentially the same manner as the modern fauna of the surface. At Hickman, Kentucky, the larger helices (so prominent in the southeastern modern fauna) already appear in large numbers and *Pyramidula solitaria,* carinate *Pyramidula alternata, Polygyra tridentata,* very large *P. albolabris,* large *P. profunda,* a few *P. elevata, P. fraterna, P. fraudulenta, P. appressa, Omphalina fuliginosa,* large *Circinaria concava,* more abundant *Pyramidula perspectiva* and *Gastrodonta ligera.* These species already form the most conspicuous feature of the loess fauna. *Helicina occulta* still appears, though here approaching its southern limit. Still farther south at Dyersburg, Tennessee, a similar fauna appears in the loess, but *Helicina occulta* is not common, reaching here its southern limit and *Pyramidula striatella,* so common in the north, also becomes rare. Still farther south on the west side of the Mississippi River at Helena, Arkansas, the loess fauna becomes still more characteristically southern, and in addition to the larger helices already mentioned the large

form of *Succinia ovalis, Omphalina kopnodes, Vitrea placentula* and *Helicina orbiculata* appear in conspicuous numbers. The last three species are distinctively southern. *Helicina occulta* has wholly disappeared and its place has been taken by *Helicina orbiculata.* The richly fossiliferous loess of Natchez and Vicksburg, Mississippi, also contains the forms common at Hickman and Helena, and the presence of *Polygyra obstricta, P. inflecta* and *P. stenotrema* still further stamps the fauna as distinctively southern.

But in this variation in the wide loess region there is nothing which suggests a transition or change from cold climate to warm climate faunas or *vice versa.* The variation, as we find it in the loess is practically exactly duplicated in the modern fauna of the surface. The only conclusion, then, which can be drawn from the fossils of the loess is, that during the deposition of the several loesses climatic conditions were not materially different from those which exist in the various parts of the same general region to-day. Such differences as do exist point rather to a drier climate in the northern part of the loess-covered area than that of to-day.

Emphasis has sometimes been placed upon the depauperation in size of certain loess shells, as evidence that the climate in which they existed was colder than that of to-day. These depauperate shells are found only in the northern part of the loess area, in Iowa, Nebraska, etc. Their exact counterparts are found living to-day in the drier portions of the same region. And corresponding differences do not occur in more easterly series which represent differences in latitude. It is evident that the depauperation is due to drouth and not to a low temperature, and the abundance of these depauperate shells in the northern loess reinforces the evidence already noted that the climate of this region was then somewhat drier than at present.

The earlier hasty conclusion in this case illustrates only one of the difficulties which the student of geology who has not given special attention to the mollusks encounters in his efforts to determine the conditions under which various Pleistocene deposits were formed.

Another results from erroneous identifications of deposits. An illustration of this is furnished by the Otis Mill section in South Dakota opposite Chatsworth, Iowa, which has been referred to the loess. The section, in fact, consists of Aftonian silt and sand, Kansan drift and true loess. The fossils, to which reference is usually made in connection with this section are of the usual alluvial type and belong to the Aftonian part of the section only, none being found in the capping loess. Still other errors result from erroneous identifications of species. Thus *Carychium exile,* the species usually found on high ground, has been identified as *C. exiguum,* a species which is frequently amphibious. Other errors arise from the assumption that species of the same genus have the same habitats, and that their presence in various deposits indicates like conditions. This is often far from true, thus, *Zonitoides arboreus* and *Z. nitidus* are similar in appearance, and closely related, yet the former is an upland species, while the latter is found in low grounds and is sometimes amphibious. Similarly, *Succinia avara* is upland, while *S. retusa* is amphibious; *Pomatiopsis lapidaria* is terrestrial, while *P. cincinnatiensis* is found only in somewhat deeper water in large ponds and lakes; *Planorbis trivolvis* lives in shallow waters in ponds and swampy borders, while the similar *P. truncatus* is found only in the larger lakes in deeper waters. *Lymnæa palustris* and *L. emarginata* show a similar difference in

habit, the latter being a deep water form; *Physa gyrina* is a species common in small ponds, while *P. integra* prefers river borders and *P. sayi* inhabits larger ponds and lakes; and similar variations in habit may be found in the species of various genera such as *Bifidaria* and *Vertigo* among terrestrial genera, and *Amnicola* and *Pisidium* among aquatic genera.

It is, therefore, not safe to jump at conclusions on the basis of mere relationship. A student of geology who would correctly measure the conditions which prevailed during the time of deposition of the various fossiliferous Pleistocene formations must not only accurately identify the fossil species, but he must learn to know the habits of the modern representatives of the same species.[8]

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RAMSAY HEATLEY TRAQUAIR

ICHTHYOLOGISTS all over the world have read with profound regret of the death of Dr. Ramsay Heatley Traquair, the eminent authority on fossil fishes. Dr. Traquair had long been regarded as the dean of paleichthyology, and had been revered by those in his field, both for his personality and his scientific achievements, as few men ever were. It was a shock to them to realize that he was no more among them. His work in ichthyology was of a fundamental kind, like that of Huxley or of Johannes Müller in zoology, and much of it has long since become incorporated among the established principles of the science. Indeed, Dr. Traquair may be regarded as the founder of modern paleichthyology, and his name, we believe, will stand next to that of Louis Agassiz, as the most illustrious in the history of this science.

Ramsay Heatley Traquair was born at Rhynd, Perthshire, July 30, 1840. He was the youngest son of a Scottish minister. As a boy, he was sent to a preparatory school in Edinburgh, where his quiet bearing and studiousness attracted the attention of his teachers. Almost from childhood he manifested a deep love of nature, and as a boy he frequented a small natural-history shop kept by an old woman in Edinburgh, where were displayed minerals, fossils and shellfish: these no doubt stimulated his imagination and helped to nurture a growing love of natural history. As he grew older, he would go on excursions into the hills around Edinburgh in quest of paleichthyological specimens. On one of these trips, the story runs, he found a nodule with a portion of a palæoniscid fish, and was greatly surprised to learn that no book then available gave an adequate account of it. It was his ardent love of natural history that led to his choice of medicine as a profession, for this was the only science, at that time, that afforded both a foundation for natural history studies and the means of a livelihood. He entered the University of Edinburgh as a student of medicine in his seventeenth year, and he seems to have been a good student. His holidays were spent in collecting and studying fossils. As the end of his studies approached, it became more and more plain to him that he ought not to practise his profession but seek an opening in science. He took his degree in 1862, receiving a gold medal for his thesis on the asymmetry of flatfishes. In this year, too, he published his first paper, "On the Occurrence of Trilobites in the Carboniferous Limestone of Fifeshire."

For several years after graduation he held minor posts in the school of medicine, first as prosector and later as demonstrator of anatomy. This period afforded him an opportunity of acquiring skill in making anatomical preparations, besides allowing him to be near his favorite fossil hunting grounds. During 1866–67, he held the professorship of natural history in the Agricultural College at Cirencester, where he taught botany and devoted his spare time to the study of local geology

[8] A supplementary table of mollusks, containing twelve lists of fossils and six lists of shells obtained from modern drift along streams and lakes, has been published by the author, and will be sent on application to members who are specially interested.

and fossil fishes. His well-known memoir on *Pygopterus* belongs to this period, having been published in 1867.

During the next six years he held the chair of zoology in the newly established College of Science in Dublin. This post was more congenial than his previous ones, but it is plain, from the few papers published during these years, that he lacked materials for carrying on his studies in paleichthyology. His opportunity, however, came in full measure in 1873, when he was appointed keeper of natural history in the Museum of Science and Art (now the Royal Scottish Museum), at Edinburgh. Shortly before leaving Dublin he married Miss Phoebe Anna Moss, whose work as a painter was just beginning to attract attention;[1] she is the daughter of the late Dr. William Moss, of Dublin.

Dr. Traquair held the post of keeper for thirty-three years, retiring in 1906 at the age of sixty-six. His most brilliant and most lasting work was done during this time. He had at his disposal a magnificent collection of paleozoic fishes, including the materials brought together by Hugh Miller and used by him in his preparation of "Old Red Sandstone" and other works. Moreover, within easy reach of Edinburgh were a number of localities where fossil fishes could be easily procured. But it should not be thought that Dr. Traquair devoted all his time, during these years, to his studies: he gave much attention to building up the zoological collections at the museum. The synoptic exhibit in this subject, which is displayed in a large square gallery, is one of the completest, and perhaps the best of its kind, in the world. It is the admiration of all zoologists who visit the museum.

[1] Mrs. Traquair is widely known for her mural decorations. Her principal work is the series of mural paintings in the Catholic Apostolic Church in Edinburgh, which took four years to complete and is mentioned as one of the sights of Edinburgh. She has also done exquisite work in book illumination, decorative bookbinding and in enameling. For an appreciation of Mrs. Traquair's work, see A. F. Morris, "A Versatile Art Worker," *The International Studio*, XXV., 1905, pp. 339–343.

A few years after Dr. Traquair's retirement his health began to fail and during the past year or two it was felt by his friends that the end could not be far off. He died in his seventy-third year, on November 22, 1912, in his beautiful home, at the foot of the Pentland hills, at Colinton, near Edinburgh.

Many honors came to Dr. Traquair in his lifetime. He was an honorary or corresponding member of many learned societies throughout the world, including the New York Academy of Sciences, to which he was elected in 1899. He became a member of the Royal Society of London in 1881; in 1893 his alma mater conferred on him an honorary LL.D. He received a number of medals in recognition of his services to science—the Neill medal of the Royal Society of Edinburgh in 1878, and the Makdougall-Brisbane in 1901; the Lyell medal of the Geological Society of London (1902), and a Royal medal of the Royal Society in 1907.

Dr. Traquair's studies were embodied in about 130 memoirs.[2] He was not a voluminous writer, as natural history writers go these days, but whatever came from his pen was so carefully, so conscientiously elaborated, that even his smaller papers were highly valued by those in his field. Fossil fishes are often very imperfectly preserved, and authors are occasionally carried away into seeing anatomical details where none really exist. But Dr. Traquair never let his imagination have sway where his specimens were imperfect. His accuracy was almost proverbial. Considering the vast amount of detail contained in his papers, it is remarkable how little of it has ever been debated. Indeed, Dr. Traquair has been considered by some even over careful, so that his results were sometimes held back for a long time before publication. Thus, Dr. A. S. Woodward has lately pointed out that Dr.

[2] A bibliography of Dr. Traquair's scientific writings appeared in the *Geol. Mag.*, dec. v, Vol. VI., 1909, pp. 245–250. His last publication was the memoir, "Les Poissons Wealdiens de Bernissart," published in 1911 (*Mém. Musée Roy. d'Hist. Nat. de Belgique*, VI., pp. iv + 65, 12 pls.).

Traquair had a specimen of *Palæospondylus* for years in his possession before publishing it to the world: he had apparently waited in the hope of being able to throw additional light on this elusive fossil.

The work of Dr. Traquair may be described as that of a morphologist working out anatomical structures as a key to relationships, rather than that of a systematist. Still he described, as one should, such new species as came his way—perhaps a hundred in all. His greatest service was in establishing clearly the limits and the relationships of certain of the larger groups, such as the lungfishes and the Actinopterygia, and in carrying their history back to the early Devonian. In his classic memoir on the Palæoniscidæ, he showed on evidence that is now accepted as incontrovertible—but which none the less was not at all evident before he took up these obscure fossils—that these fishes are related to the sturgeons, especially to such forms as *Polyodon,* and not, as previously believed, to the gar pikes. This conclusion was of far-reaching importance, leading to a modification of many other ideas of the inter-relationships of the groups of fishes. The flattened, compressed Platysomidæ, he proved, are a specialized branch of the Palæoniscidæ; and he showed conclusively that *Cheirolepis* was a primitive ganoid, not an Acanthodian, and thus traced back the history of the acanthopterygian fishes almost as far back as that of any other group. He was the first to prove that the Devonian *Dipterus* was a lungfish, and thus he extended the geological history of this group. He gave us a revised study of the Arthrodire, *Coccosteus,* on which one or two restorations by other writers were subsequently based; and it was he who first clearly defined the characters of *Homosteus* and of *Phlyctænaspis.* He was the first to bring together our scattered knowledge of *Pterichthys* and to give a restoration of this form; and he, also, worked out the anatomy of that primitive type, *Drepanaspis.* To Traquair also must be credited whatever knowledge we possess of those extraordinary forms *Thelodus* and *Lanarkia,* which gave us the first conception of the appearance and the structure of the earliest known vertebrates. Dr. Traquair also devoted considerable time to preparing monographs of the fishes of the Old Red Sandstone. These were published by the Paleontographical Society, and appeared in parts, as ready; these, unfortunately, are left unfinished.

These are only a few of the more far-reaching studies of Dr. Traquair which our limited space allows us to mention, but there was hardly a field of paleozoic ichthyology which he did not touch, and, as was well said by one of his biographers, he touched nothing that he did not adorn.

Personally, Dr. Traquair was a most charming man. In 1909 the writer had the privilege of seeing him almost daily at the museum or in his home. He was quiet and reserved in bearing, but he possessed a fund of humor that was all the more surprising because, on account of his quiet manner, it was not at first expected. One could not be with him many days without seeing that the man was far greater than his works. He had a deep appreciation for the beauties of nature. He had a great love for Scottish history and knew the legends concerning every name and place, whether it was Mons Meg or Holyrood Abbey. He was a most charming host, and the memory long lingers of having seen him the center of a circle at an afternoon tea, when he was the life of the whole company. He was very fond of flowers, and the artistically laid out rectangular garden, sloping down from the rear of the house at Colinton, near Edinburgh, gave him great delight, and he talked with genuine pleasure of its every plant. He was a student of modern languages, which were his hobby, and it was with amazement that one who knew only his work on fossil fishes heard him discourse, at length, on words and their history. He used to spend most of his vacations in Germany because of his great love for the language and for the ways of German savants; and he spoke the language fluently, and wrote it with a grace that is seldom achieved except in one's mother tongue.

Those who have known Dr. Traquair intimately are deeply grieved to have lost a wise and lovable friend.

L. Hussakof
American Museum of Natural History

JOHN SHAW BILLINGS

The New York Library Club has adopted the following resolution:

Resolved, That on the death of John Shaw Billings, The New York Library Club desires to record its grateful recognition of the great part which he played in the development of the library service of New York City and of the United States.

While Dr. Billings gained distinction in the profession of his first choice in medical service during the Civil War, in the organization of the U. S. Marine Hospital Service and of the Johns Hopkins Hospital, as director of the University of Pennsylvania Hospital and professor of hygiene in that institution, as expert in charge of the division of vital statistics of the tenth and eleventh censuses, and as a writer upon medical subjects, it is as one of the most eminent members of our own profession that we honor his memory.

Called in 1895 to be director of the newly established New York Public Library, he gave an impetus to the growth of its collections almost without parallel in the history of libraries and ensured their permanent value by making the collections of government publications and periodicals his first object. He was instrumental in the establishment of a remarkable system of branch libraries and planned the unique library building which contains the library's reference collections and is the center of its circulation department. As members of this club we will honor Dr. Billings as the most distinguished of all those who have served the library interests of this community.

As librarians, however, we will remember also his remarkable achievements as librarian of the Surgeon General's Office, in the development of the largest medical library in the world, in the publication of the most important of medical bibliographies, the "Index Catalogue," as well as the most useful, the "Index medicus," and in the inauguration of a national library service.

And as bibliographers we will remember also his services as delegate of the United States to the congress held in London in 1896 which established the International Catalogue of Scientific Literature.

He was a member of this club and its president in the year 1900, a member of the American Library Association and its president in the year 1902, a member of many learned societies, honored by learned institutions and societies, both at home and in foreign lands.

He gave to his profession the service of a scientist interested in the most common problems, the labors of a specialist with the broadest sympathies.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING[1]

The seventh annual report of the president and treasurer of the Carnegie Foundation, which has just appeared, covers the year ended September 30, 1912.

The endowment in the hands of the trustees at that time amounted to approximately $14,000,000, and the income for the year amounted to $676,486, of which $634,497 was expended. From its first pension payment in June, 1906, to the end of the fiscal year September 30, 1912, the foundation has distributed $2,077,814 in retiring allowances to professors and $238,590 in widows' pensions—a total of $2,316,404. In all 429 retiring allowances and 90 widows' pensions have been granted, of which 98 have terminated through death and 23 at the expiration of temporary grants, leaving 315 retiring allowances and 83 widows' pensions in force at the end of the year.

The report of the president, like the former reports, is divided into two parts—the first referring to the current business of the year and dealing with questions more directly pertaining to the administration of the foundation; the second part being devoted to current educational problems of a larger and more general nature.

The first part of the report includes a careful statement of the whole question of pensions for teachers, for government employees and for industrial employees. This statement contains the results of the examination of practically all of the pension systems now in operation anywhere, and leads finally to a discussion of a feasible pension system for the public school teachers of a state. This discussion is particularly needful at this time, since the question of teachers' pensions is a matter under consideration by a number of state legislatures. As the report points out, the bills which have been introduced in the various legislatures almost without exception

[1] Official summary sent by the foundation.

violate fundamental actuarial conditions, and have been framed without study of the essential conditions which must be fulfilled by any adequate pension system. The material brought together in this report, the examples of the failures of pension systems which have occurred—as, for example, that in New South Wales—and the precarious situation in which many state pension systems now stand, make this portion of the report one of great practical value to the authorities of any state contemplating pensions either for teachers or for state employees.

President Pritchett, in arguing finally for some form of contributory pension system for public school teachers, points out clearly the difficulties of the contributory system, the necessity for the most careful actuarial advice and the public nature of the questions which are involved in a distribution of the cost of such a pension system between the state and the teacher.

Following the discussion of these pensions, a complete history of the methods by which the Carnegie Foundation pensions were arrived at is given; the process through which the trustees worked is told in the frankest manner; the difficulties which they encountered and the differences which arose out of the fact that the pensions of the Carnegie Foundation are not contributory, but have come as the result of a free gift, are made clear. The literature on pensions now at the disposal of the foundation is probably the most complete in the statement of such problems that has ever been brought together, and the discussion here made can not fail to be of value to a college, a state or an industrial association which is studying the pension problem; and the pension problem to-day is one of the insistent problems of modern social progress.

The second part of the report is devoted to such subjects as the matter of college entrance requirements, admission to advanced standing, a statement of medical progress, university and college financial reporting, advertising as a factor in education, education and politics, and finally, sham universities.

All of these subjects are discussed in the frank and specific manner which has hitherto been used in these reports. In recounting the extraordinary medical progress of the last five years attention is called to the connection which still exists in the United States between reputable colleges and unworthy medical schools. The lessons of the recent Bulletin on Medical Education in Europe are also brought clearly forward. During the last five years the mortality among unworthy medical schools has been most satisfactory. The number of such schools in the United States has been reduced by about one third and the number of students attending them by about one quarter, and this diminution has occurred in exactly the places where it ought to occur —namely, in the elimination of the unfit.

The section devoted to education and politics discusses not only the recent remarkable changes in the University of Oklahoma, the University of Kentucky and the University of Montana, but also deals with two other tendencies in political life which are profoundly affecting education: first, with the rivalry which comes from competing state institutions, and secondly with the practise inaugurated almost wholly within the last ten years in states where there are no state universities, of subsidizing institutions that are under private control. In a number of states this process has gone on until it has enormously increased the number of privately controlled institutions which share in state appropriations. So marked has this tendency become that the question of state appropriation to education without state control is one which ought now to be frankly and squarely met.

Under sham universities the report deals with conditions such as hold, for example, in the District of Columbia, where commercial enterprises without endowment or facilties are chartered as educational institutions under the loosest conditions, which enable them to appeal to the credulity of ignorant students throughout this and other countries under high-sounding names and under the shelter of charters granted by the general government. A bill now before Congress aims to correct this situation.

The report will be sent upon request to the Carnegie Foundation, 576 Fifth Avenue, New York City.

THE PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

The third annual meeting of the Pacific Association of Scientific Societies will be held at the University of California, Berkeley, April 10–12. The number of constituent societies has increased to fourteen, representing a membership of 2,167.

The Technical Society of the Pacific Coast,
The Cordilleran Section of the Geological Society of America,
The Seismological Society of America,
Pacific Coast Branch of the American Historical Association (not meeting),
The Pacific Slope Association of Economic Entomologists,
Pacific Coast Paleontological Society,
The Philological Society of the Pacific Coast,
The Cooper Ornithological Club,
California Academy of Sciences (not meeting),
Biological Society of the Pacific Coast,
California Section of the American Chemical Society,
Astronomical Society of the Pacific,
The Geographical Society of the Pacific (not meeting),
Puget Sound Section of the American Chemical Society.

The San Francisco Section of the American Mathematical Society will also hold its annual meeting at the University of California on April 12.

The Le Conte Club will hold its annual meeting and dinner at the Faculty Club, Friday evening, April 11.

The General Session of the Pacific Association will be held in California Hall on Saturday evening when an address of welcome will be given by President Benjamin Ide Wheeler, of the University of California. Three papers of general scientific interest will be read by representative members of the constituent societies.

The Southern Pacific, Santa Fe, Western Pacific, Oregon-Washington, Great Northern and Northern Pacific Railroads, have granted the usual convention rates for the states of Nevada, California, Oregon and Washington.

SCIENTIFIC NOTES AND NEWS

The spring meeting of the council of the American Association for the Advancement of Science will be held at the Cosmos Club, Washington, D. C., on the afternoon of Tuesday, April 22, 1913, at 4:45 oclock.

The issue of *Nature* for March 6 contains a portrait of Sir J. J. Thomson, with an appreciation of his contributions to physics by Augusto Righi, professor of experimental physics in the University of Bologna.

To celebrate the seventieth birthday of Dr. Paul Groth, professor of mineralogy in the University of Munich and editor of the *Zeitschrift für Crystallographie,* it is planned to place a bronze bust in the Mineralogical Institute of the University of Munich. Dr. G. Seligmann, of Coblenz on the Rhine, is treasurer of the committee.

The senate of the University of Dublin has approved the conferment of the honorary degree of doctor of science upon Professor A. C. Seward, F.R.S., and Professor the Hon. R. J. Strutt, F.R.S.

The degree of M.A. has been conferred by a decree of convocation of the University of Oxford on Professor W. H. Perkin, F.R.S., fellow of Magdalen College, the recently elected Waynflete professor of chemistry.

Mr. A. Harker has been nominated to represent the University of Cambridge at the twelfth International Geological Congress to be held in Canada in August next.

The Geological Society of France has awarded its Gaudry medal to Professor Edward Suess, of the University of Vienna.

It is stated in *Nature* that the founder's royal medal of the Royal Geographical Society is not awarded this year, but a casket with a suitable inscription will be presented to Lady Scott, to contain the patron's medal and the special Antarctic medal awarded to her late husband, Captain R. F. Scott, in 1904. The patron's medal has been awarded to the late Dr. E. A. Wilson, of the National Antarctic

expedition, and a gold watch to Lieutenant Campbell, who led the northern party of the same expedition. The Victoria medal is awarded to Colonel S. G. Burrard, F.R.S.; the Gill memorial to Miss Lowthian Bell; the Murchison award to Major H. D. Pearson; the Cuthbert Peek grant to Dr. Felix Oswald; and the Back bequest to Mr. W. S. Barclay.

THE position of chief of the Forest Service, now held by Professor Henry S. Graves, who succeeded Mr. Gifford Pinchot, has been placed under the classified civil service. The position will become vacant only on voluntary resignation or on removal for failure to carry out properly the duties of the office.

THE expedition to explore the regions of the Amazon left Philadelphia for the south on the yacht *Pennsylvania* on March 19. The expedition is being made under the auspices of the University of Pennsylvania Museum, and will extend over a period of three years. The leader of the expedition is Dr. William C. Farrabee, curator of the American section of the museum. The yacht is in command of Dr. J. H. Rowen, a retired officer of the U. S. Navy. The other members of the expedition are: Dr. Franklin B. Church, who will make a special study of tropical diseases, and Mr. Sandy McNabb, a traveler of wide experience.

PROFESSOR W. A. HENRY, emeritus professor of agriculture of the University of Wisconsin and for many years dean of the College of Agriculture, is on his way back from a trip to Panama, Jamaica and Cuba. He will spend some time at his large peach farm near Wallingford, Conn.

THE Cutter lectures on preventive medicine and hygiene will be given at the Harvard Medical School by George C. Whipple, professor of sanitary engineering, Harvard University, on "The Use of Vital Statistics." The dates and subjects are: March 31, "With Truth"; April 2, "With Imagination"; April 5, "With Power."

BEFORE the Geographic Society of Chicago, on March 28, at Fullerton Hall, a lecture was given by Professor Merritt L. Fernald, of Harvard University, the title being "The Mountains and Barrens of Newfoundland and the Gaspé Peninsula."

MR. F. E. MATTHES, of the U. S. Geological Survey, gave a lecture on March 18 before the Appalachian Mountain Club of Boston on "The Glaciers of Mount Rainier." On March 19 he repeated this lecture at Wellesley College. On March 20 he spoke to the classes in civil engineering and mining of the Massachusetts Institute of Technology on "The Sculpture of the Yosemite Valley and the manner in which it is brought out on the Yosemite Map." On March 22 he spoke to the classes in civil engineering, mining and geology of Dartmouth College on the "Delineation of Land Forms as Exemplified by the Map of the Yosemite Valley."

VLADIMIR KARAPETOFF, professor of electrical engineering at Cornell University, will address students at four southern colleges, namely, Clemson College, S. C., on April 2; Georgia School of Technology at Atlanta, on April 4; Alabama Polytechnic Institute in Auburn, on April 7, and University of Tennessee at Knoxville, on April 10. In each of these places he is scheduled for three events: a lecture for electrical students on electrostatic and magnetic circuits, a general address on the development of personality and a lecture-recital on musical expression.

A MEMORIAL window to Ralph Stockman Tarr, late professor of physical geography in Cornell University, who died March 20, 1912, was dedicated in Sage Chapel last week. The window was unveiled by Professor Lawrence Martin, of the University of Wisconsin, formerly an assistant under Professor Tarr. Acting President Crane accepted the memorial on behalf of the university.

DR. IRA VAN GIESON, formerly instructor in pathology in Columbia University, and at one time director of the New York State Pathological Institute, died in New York City on March 24.

DR. PRINCE ALBERT MORROW, the eminent dermatologist of New York City, died on March 17, aged sixty-six years.

Dr. E. G. Ravenstein, who did much to improve cartographical methods in Great Britain, has died at the age of seventy-nine years.

Dr. F. Howitz, formerly professor of gynecology in the University of Copenhagen, has died at the age of eighty-four years.

The deaths are also announced of Professor G. Vassale, who held the chair of general pathology at the University of Modena, and of Professor Albanese, who held the chair of pharmacology at Rome.

The U. S. Civil Service Commission announces examinations towards the end of the month for assistant chemist in the office of public roads at salaries ranging from $1,800 to $2,200; for examiner of surveys in the Forest Service, at salaries of from $1,200 to $1,500, and of preparator of fossils in the Geological Survey, at a salary of $900.

By the recent British insurance act it is provided that one penny per insured person, payable out of the moneys provided by parliament, may be retained by the insurance commissioners to be applied for the purposes of research, and the total sum thus available will at present amount to about £57,000 per annum. While the main concern of this part of the act is to combat tuberculosis, the commissioners have been advised that the money may properly be applied to research in connection with any disease which may affect insured persons.

By the will of Carll H. De Silver, of Brooklyn, the Brooklyn Institute of Arts and Sciences receives $50,000.

The twentieth semi-annual meeting of the Association of Teachers of Mathematics in the Middle States and Maryland was held at the University of Pittsburgh on March 22.

The fifth annual meeting of the Illinois Water Supply Association was held at the University of Illinois on March 11 and 12. The membership of the association is made up of waterworks engineers, superintendents, chemists, and others interested in obtaining and conserving an abundant supply of pure water. The papers read at this meeting covered a wide range of subjects, including the study of deep well drillings in Illinois, sterilization of water by ultra-violet light, filter plants, practical methods of obtaining efficiency in waterworks pumping plants, bacterial examination of water supplies, conditions in small filter plants, appraisal of waterworks properties, fire streams and municipal laboratories. About one hundred and twenty-five members attended the meeting. The officers elected for the next year are: President, C. H. Cobb, superintendent, Kankakee Waterworks; First Vice-president, H. M. Ely, superintendent and manager, Danville Water Company; Second Vice-president, W. J. Spaulding, commissioner of Public Property, Springfield; State Vice-president, V. E. MacDonald, superintendent, Lincoln Water and Light Company, and secretary and treasurer, Professor Edward Bartow, director, State Water Survey.

A room in the Geological Museum of Harvard University has been fitted with cases for twelve relief maps and models which have been recently acquired. One of these is a copy of the model of the Mt. Sentis, on the borders of the Swiss cantons St. Gall and Appenzell. This model was done by Mr. G. C. Curtis, '96, and took first prize at the World's Exposition in Paris in 1900. There is also a relief map of southern New England done by Mr. Edwin E. Howell.

A total working income of approximately $35,000,000 was received by 87 state universities and other state-aided institutions of higher education during the past year, as shown by a bulletin just issued by the United States Bureau of Education. Of this amount the United States government contributed about $5,000,000 and the states $18,000,000. The year's income passed the two million mark in the case of three state universities. The University of Illinois had an income during 1911–12 of $2,363,711; the University of Minnesota, $2,682,499; and the University of Wisconsin, $2,122,297. Cornell University, which is technically a private institution but receives state and federal aid, reported total

receipts of over three million dollars with a net income available for current expenses of about a million and a half. Several other state-aided institutions are in the million-dollar income class. These include the University of Michigan, which had an income of $1,343,057; Ohio State University, with $1,011,571; and the University of California, with $1,711,393. The latter had an additional half million from private benefactions. The state of Iowa supports several institutions of college and university rank with a combined income of over two million dollars. Some of the states are exceedingly generous to their colleges and universities, and in such cases the national government's contribution is only a small fraction of the total. Illinois meets the government's $80,000 with nearly two million dollars from state funds, and there are several other states that are similarly liberal. Most of the states give to higher education a greater sum than they receive from the United States government. On the other hand, a few states depend to a considerable extent upon Uncle Sam's bounty. The state of Delaware provided $22,000 last year for Delaware College, to accompany the $70,000 received from federal funds; in Maryland the state itself furnished $36,000 for the Agricultural College, against $80,000 received from the federal government; New Hampshire's contribution to the State College was $20,955; and the state of Vermont gave only $26,000 out of a total income of $277,815 reported by the state university, while $80,000 was derived from the United States government and $60,958 from private benefactions. In some of the larger state-aided universities, tuition fees from students have become an important factor in the annual income; and others that are to a certain extent public institutions have private benefactions that yield a permanent working revenue. Thus the University of Vermont has considerable endowment; Massachusetts Institute of Technology, though aided somewhat by state and national government, depends for the bulk of its income upon the students' fees and private funds; and Cornell University received nearly half a million from each of three sources, namely, students' fees, productive funds and state appropriations.

UNIVERSITY AND EDUCATIONAL NEWS

THE legislature of Missouri, at its biennial session, has appropriated for the support and buildings of the University of Missouri during 1913–14 $1,417,500. Included in this are appropriations of $200,000 towards a library building; $100,000 for a biological laboratory, and $25,000 for a live stock judging pavilion. In addition to the above the Agricultural College, which is a part of the university, receives $142,000. Of this appropriation $50,000 is for hog cholera serum; Agricultural Experiment Station, $30,000; county farm advisers, $25,000; soil experiment fields, $20,000; state soil survey, $12,000, and Corn Growers' Association, $5,000.

MESSRS. ANDREW W. MELLON and Richard B. Mellon, of Pittsburgh, have announced their purpose to erect on the campus of the University of Pittsburgh a laboratory for the department of industrial research to cost not less than $150,000, to equip the same, and provide a fund of $40,000 per annum for the coming five years for its maintenance. This department of the university is under the immediate care and oversight of Dr. Robert Kennedy Duncan, the well-known leader in industrial research.

A HOLDING trust has been formed in Massachusetts called the Harvard Mutual Foundation. It will receive gifts from those desiring to leave money to Harvard University, pay 5 per cent. interest to the donor or his immediate heirs during their lives, and at their deaths turn over the principal to the university. The fund starts with $250,000. The foundation is controlled by the university, in that its trustees will be named by the corporation, and that body will have a certain voice in the management of the trust. The first trustees are the following: Charles Francis Adams, 2d, '88, treasurer of the university; T. N. Perkins, '91; Arthur Lyman, '83; George U. Crocker, '84; John C. Cobb, Jr., '00; Alexander H. Ladd, '97, and C. H. W. Foster, '81.

In 1909 the Goldsmiths Company gave £50,000 towards the extension of the engineering department in the Central Technical College, London. We learn from *Nature* that the company has now offered to pay the entire cost of the new building, which means an added gift of £37,000. The Goldsmiths' Company has attached the condition that the portion of the capital belonging to the Imperial College of Science and Technology, which will be thus set free, shall be added to the endowment fund, the income being used for higher educational and research work.

The union of the University of Maryland medical department and the Baltimore Medical College is assured, the faculties having agreed on the terms of merger. Members of the faculty of the latter institution will retain their positions in the new school and three of them will become members of the university board of regents.

The amalgamation of the two medical schools in Richmond, Va., has now been consummated. On March 22 the following appointments to the faculty were made by the board of visitors:

Professors

W. G. Christian, anatomy.
W. A. Shepherd, histology and embryology.
Wortley F. Rudd, chemistry.
Alfred L. Gray, physiology.
S. B. Moon, pathology (acting).
Francis W. Upshur, pharmacology and therapeutics.
William S. Gordon, medicine.
McGuire Newton, pediatrics.
Beverly R. Tucker, neurology and psychiatry.
E. P. McGavock, dermatology.
George Ben Johnston, surgery.
Lewis C. Bosher, genito-urinary surgery.
Joseph A. White, ophthalmology.
John Dunn, otology, rhinology and laryngology.
John F. Winn, obstetrics.
Charles R. Robins, gynecology.
Edward McGuire, clinical medicine.
Manfred Call, clinical medicine.
J. Allison Hodges, clinical neurology and psychiatry.
Stuart McGuire, clinical surgery.
Hugh M. Taylor, clinical surgery.

Associate Professors

John W. Brodnax, anatomy.
E. C. L. Miller, chemistry (physiological).
C. Howard Lewis, physiology.
E. Guy Hopkins, pathology (clinical).
Aubrey H. Straus, bacteriology.
Ennion G. Williams, hygiene and public health.
Leslie B. Wiggs, materia medica and pharmacology.
A. G. Brown, medicine (theory and practise).
J. McCaw, Thompkins, medicine (theory and practise).
J. Garnet Nelson, medicine (physical diagnosis).
Dougless van der Hoof, clinical medicine.
St. George T. Grinnan, pediatrics.
Roshier W. Miller, neurology and psychiatry.
G. Paul La Roque, surgery (practise).
James W. Henson, surgery (principles).
A. Murat Willis, surgery (operative).
William W. Dunn, surgery (minor).
W. Loundes Peple, clinical surgery.
William P. Mathews, orthopedic surgery.
R. C. Bryan, genito-urinary surgery.
R. H. Wright, ophthalmology.
S. C. Bowen, otology and rhinology.
Clifton M. Miller, laryngology.
Greer Baughman, obstetrics.
Stuart Michaux, gynecology.

Twenty-seven of these men were formerly connected with University College of Medicine and nineteen with the Medical College of Virginia.

Professor Ira N. Hollis, since 1893 professor of engineering at Harvard University, has accepted the invitation of the trustees of the Worcester Polytechnic Institute to become president of that institution.

Professor W. C. Ruediger, who has been acting dean of the Teachers College at the George Washington University since the death of Dean Hough last September, has been appointed dean.

Professor Jores, of Cologne, has been appointed director of the Institute of Pathology at Marburg.

Professor Lubarsch, of Düsseldorf, has succeeded the deceased Professor Heller as director of the Institute of Pathology at Kiel.

DISCUSSION AND CORRESPONDENCE

THE COMPLEXITY OF THE MICROORGANIC POPULATION OF THE SOIL

DURING the last few years a series of experiments have been carried out in this laboratory by Dr. Hutchinson and myself[1] which we can only interpret as showing that bacteria are not the only active inhabitants of the soil. The results in our view point conclusively to the presence of another group of organisms, detrimental to bacteria and differing from them by their larger size, slower rate of multiplication under soil conditions. and lower power of resistance to heat and antiseptics. They are, therefore, more readily killed than bacteria, and we regard their suppression as an important factor in bringing about the increased bacterial activity known to set in after soil has been partially sterilized or treated in any other way detrimental to active life. Such properties as we could ascertain agree with those of protozoa; we were thus led to look for these organisms in the soil and found numbers of them. We adduced reasons for provisionally identifying the detrimental organisms with the soil protozoa.

Recently several papers have been published in the United States controverting these conclusions. We are not satisfied, however, that the criticisms affect the validity of our arguments, and therefore desire to set out briefly the experimental facts and the conclusions we draw from them. The actual data are to be found in our papers in the *Journal of Agricultural Science;* many of the figures were also presented to the Graduate School of Agriculture at East Lansing last July.

1. We begin with the fact that partial sterilization of soil, *i. e.,* heating it to a temperature of 60° C. or more, or treatment for a short time with vapors of antiseptics such as toluene, causes first a fall and then a great rise in bacterial numbers. The rise sets in soon after the antiseptic has been removed and the soil conditions once more made favorable for bacterial development; it goes on till the numbers far exceed those present in the original soil.

2. Simultaneously there is a considerable increase in the accumulation of ammonia. This sets in as soon as the bacterial numbers begin to rise, and the connection between the two quantities is normally so close as to indicate a causal relationship; the increased ammonia production is, therefore, attributed to the increased numbers of bacteria. There is no disappearance of nitrate; the ammonia is formed from organic nitrogen compounds.

3. The increase in bacterial numbers is the result of improvement in the soil as a medium for bacterial growth and not an improvement in the bacterial flora. Indeed the new flora *per se* is less able to attain high numbers than the old. This is shown by the fact that the old flora when reintroduced into partially sterilized soil attains higher numbers and effects more decomposition than the new flora. Partially sterilized soil *plus* 0.5 per cent. of untreated soil soon contains higher bacterial numbers per gram and accumulates ammonia at a faster rate than partially sterilized soil alone.

4. The improvement in the soil brought about by partial sterilization is permanent; the high bacterial numbers being kept up even for 200 days or more. The improvement, therefore, did not consist in the removal of the products of bacterial activity, because there is much more activity in partially sterilized soil than in untreated soil. Further evidence is afforded by the fact that a second treatment of the soil some months after the first produces little or no effect.

It is evident from (3) and (4) that the factor limiting bacterial numbers in ordinary soils is not bacterial, nor is it any product of bacterial activity, nor does it arise spontaneously in soils.

5. But if some of the untreated soil is introduced into partially sterilized soil the bacterial numbers, after the initial rise (see (3)), begin to fall. The effect is rather variable, but is usually most marked in moist soils that have been well supplied with organic ma-

[1] *Journal of Agricultural Science,* 1909, 3: 111–144; 1912, 5: 27–47, 86–111; 1913, 5: 152–221.

nures; *e. g.*, in dunged soils, greenhouse soils, sewage farm soils, etc. Thus the limiting factor can be reintroduced from untreated soils.

6. Evidence of the action of the limiting factor in untreated soils is obtained by studying the effect of temperature on bacterial numbers. Untreated soils were maintained at 10°, 20°, 30° C., etc., in a well moistened aerated condition, and periodical counts were made of the numbers of bacteria per gram. Rise in temperature rarely caused any increase in bacterial numbers, sometimes it had no action, often it caused a fall. But after the soil was partially sterilized the bacterial numbers showed the normal increase with increasing temperatures. Similar results were obtained by varying the amount of moisture but keeping the temperature constant (20° C.). The bacterial numbers in untreated soil behaved erratically and tended rather to fall than to rise when the conditions were made more favorable to trophic life; on the other hand, in partially sterilized soil, the bacterial numbers steadily increased with increasing moisture content. Again, when untreated soils are stored in the laboratory or glasshouse under varying conditions of temperature and of moisture content the bacterial numbers fluctuate erratically; when partially sterilized soils are thus stored the fluctuations are regular.

7. When the curves obtained in (6) are examined it becomes evident that the limiting factor in the untreated soils is not the *lack* of anything[2] but the *presence of something active.*

8. This factor, as already shown, is put out of action by antiseptics and by heating the soil to 60° C., and once out of action it does not reappear. Less drastic methods of treating the soil put it out for a time, but not permanently: *e. g.*, heating to 50°, rapid drying at 35°, treatment with organic vapors less toxic than toluene (*e. g.*, hexane), incomplete treatment with toluene. In all these cases the rise induced in the bacterial numbers per gram is less in amount than after toluene treatment and is not permanent; the factor sets up again. As a general rule, if the nitrifying organisms are killed, the limiting factor is also extinguished; if they are only temporarily suppressed the factor also is only put out for a time.

9. The properties of the limiting factor are: (*a*) It is active and not a lack of something (see (7)); (*b*) it is not bacterial (see (3) and (4)); (*c*) it is extinguished by heat or poisons and does not reappear if the treatment has sufficed to kill sensitive and non-spore-forming organisms; it may reappear, however, if the treatment has not been sufficient to do this; (*d*) it can be reintroduced into soils from which it has been permanently extinguished by the addition of a little untreated soil; (*e*) it develops more slowly than bacteria and for some time may show little or no effect, then it causes a marked reduction in the numbers of bacteria, and its final effect is out of all proportion to the amount introduced; (*f*) it is favored by conditions favorable to trophic life in the soil.[3]

10. We see no escape from the conclusion that the limiting factor is a living organism. We were, therefore, led to search for organisms not bacteria, slower growing, less resistant and larger. Protozoa naturally suggested themselves. We soon found numbers of ciliates, amœbæ and flagellates and induced Mr. Goodey to study them in detail. This work is still continuing, and promises highly interesting results: some remarkable forms have been picked out, and it is already evident that the zoological survey of the soil will be a prolonged business but will be eminently worth while. The ciliates and amœbæ are killed by partial sterilization. *Whenever they are killed the detrimental factor is found to be put out of action,* the bacterial numbers rise and maintain a high level. Whenever the detrimental factor is not put out of action the protozoa are not killed. To these rules we have found no exception. Some exceptions have been found to the converse proposition,

[2] The soils we used included fertile loams well supplied with organic matter, calcium carbonate, phosphates, etc.

[3] This is dealt with fully in the *Journal of Agricultural Science,* 1912, 5: 27, 86.

i. e., we have sometimes found ciliates and amœbæ in soils in which the detrimental factor had been put out of action, but our present methods do not enable us directly to discriminate between protozoan cysts and active forms, nor to estimate the numbers present, nor, on the other hand, to determine how completely the detrimental factor is put out of action. But in general the parallelism between the detrimental factor and the soil protozoa is so complete that we are justified in provisionally regarding protozoa as the detrimental organisms we have been seeking.

Such is a short statement of the main lines of the work. I have omitted the subsidiary issues: the vain search for bacteriotoxins,[4] for evidence of bacterial stimulus, of improvements in the bacterial flora, etc. The identification of the detrimental organisms with the soil protozoa is provisional only; in the nature of the case a rigid proof would be very difficult even if it were possible.

I now turn to some of the criticisms that have been passed on this work by my American colleagues. Dr. Jacob G. Lipman at the New Jersey Station, in conjunction with Messrs. Blair, Owen and McLean, carried out some experiments,[5] the results of which they consider to be in direct opposition to ours. They added pasteurized and untreated soil infusions respectively to mixtures of dried blood and sterilized soil (heated under a pressure of 1.5 atmospheres of steam). After seven days the pasteurized infusions had induced the formation of no more ammonia than the untreated infusion. These results, they say, "do not bear out Russell and Hutchinson's contention as to the part played by protozoa in depressing the activities of soil bacteria."

[4] This result is not necessarily in contradiction with those obtained by the Bureau of Soils. I understand that Dr. Schreiner's toxin is obtained from badly drained, badly aerated soils deficient in calcium carbonate: our soils, on the other hand, were well drained, well aerated and well supplied with calcium carbonate.

[5] Bull. 248. 1912.

The argument is ingenious, but it does not appear to us to bear on the question. In the first place, soil sterilized by heating under a pressure of 1.5 atmospheres has undergone very considerable decomposition. We have obtained evidence that such highly heated soil is altogether different from normal soil as a medium for the growth of microorganisms. Failure of protozoa to develop in the highly heated soil would be no evidence at all of their inability to develop in ordinary soil. As a matter of fact the nitrifying organisms do not seem to have developed; would Dr. Lipman argue that the results "do not bear out the usual contention as to the part played by the nitrifying organisms in the soil"? Secondly, even if the detrimental organisms could develop in highly heated soil they were not given the chance: we have never observed any development in anything like so short a period as seven days, our experiments have always been continued much longer. Lastly, the action of the detrimental organisms is to keep down the *numbers* of bacteria. Now the rate of ammonia production is not necessarily a measure of bacterial numbers and therefore affords no rigid test of the activity of the detrimental organisms.

Dr. G. E. Stone, of the Massachusetts Experiment Station,[6] who has had great experience of soil sterilization and informs us that he has "experimented with practically everything there is in this line," is convinced that protozoa "have little or no part in accounting for the increased number of bacteria in our soils." The evidence is based on some experiments by Messrs. Lodge and Smith. Decoctions were made of untreated soil and of soil heated for 45 minutes to 250° F.; into each of these decoctions soil bacteria were introduced. Greater bacterial development occurred in the decoction of the sterilized soil than in the decoction of the untreated soil. (A subsoil behaved differently.) The authors state that protozoa were absent and that the results must be due to other causes. With this I entirely agree; a decoction of a highly

[6] Twenty-fourth Annual Report, 1912.

heated soil is manifestly very different from a decoction of untreated soil; it contains much larger quantities of dissolved substances and may be expected to behave differently as a medium for bacterial development. The experiment proves conclusively that heating a soil to 250° F. causes decomposition, but I can not see that it helps us to find out what is going on in an unheated soil. The authors go on to say that protozoa are "uncommon in their soils" and "very few forms were found." It would be interesting to find what is the difference between their soil conditions and those at Michigan where Dr. Rahn[7] found protozoa of the same types occurring in numbers of the same order per gram as we find at Rothamsted.

Professor G. T. Moore, writing in SCIENCE,[8] disagrees wholly and absolutely with our work; indeed he thinks that in the tangled maze of microbiological problems "the one fact which does seem to be fairly well established is that the temporary removal from the soil of the protozoa has but little bearing on the problem." We should not feel that we had lived in vain if we had merely been the humble instruments by which such a proposition was established, but again we are not satisfied as to the evidence. Professor Moore asserts that soil protozoa are not killed by toluene, carbon disulphide, etc., but are only temporarily depressed, and after three days their numbers may equal or even exceed those originally present. Never on any occasion have we observed anything of this kind.

In an admirable paper[9] on the effects of heat on the soil Drs. Seaver and Clark attribute to us the claim that the increased productiveness of heated soils is due to the destruction of protozoa. We wish to point out that we have always regarded the destruction of detrimental organisms as only one factor in the case, and have fully recognized the effects of the decomposition brought about by the heat. In order to minimize these decomposition effects we generally treat our soils with vapors of antiseptics rather than by heat, but here also we do not lose sight of the possibility of other changes being induced besides the destruction of life.

Finally, we may be allowed to remind the reader that the adverse effect of our detrimental organisms is on the numbers of bacteria, but that the relationship of bacterial numbers to soil fertility is by no means simple. Fertility is determined by any of the factors capable of limiting plant growth. In some soils it may be the supply of phosphates, of potash, of water that is inadequate; if so, soil bacteria may show little or no connection with fertility. Only when the supply of nitrogen compounds becomes a limiting factor do the soil bacteria come in, and even then the relationship between their numbers and their activity is not quite straightforward. We have traced out this problem in detail in our paper in the *Journal of Agricultural Science*, 1913, p. 152.

We do not underrate the complexity of soil fertility problems and, above all, we do not assert that our destructive organisms are the only things involved in the matter, but we do claim that they are an important factor. Our only hope of getting any further with the complex problems of the soil is to study the factors one at a time. We must not be confused by the circumstances that other factors remain to be studied, nor, on the other hand, must we lose sight of the possibility that these other factors may vitiate some of our experiments.

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[7] *Centr. Bakt. Par.*, 1913, 36: 419–421.
[8] November 8, 1912.
[9] *Biochemical Bulletin*, 1912, 1: 413.

TWO ADDITIONS TO THE MAMMALIAN FAUNA OF MICHIGAN

THE northern pine vole, *Microtus pinetorum scalopsoides* (Audubon and Bachman) has apparently not been recorded from Michigan, and up to last year no Michigan specimen had been secured by the museum. In April, 1912, a specimen (No. 42,558, Museum of Natural History, University of Michigan) was taken by W. A. Brotherton, near Rochester, Oak-

land County, and since that time the writer has examined two specimens from the collection of the Michigan Agricultural College, both of which were secured near East Lansing, one on April 20, 1901, by D. S. Bullock, and the other in August, 1896, by T. L. Hankinson.

Another species apparently new to the Michigan fauna is Richardson's shrew, *Sorex richardsonii* Bachman, a specimen of which, taken at Chatam, Alger County, August 28, 1900, is in the collection of the Michigan Agricultural College. Although Seton[1] includes the northern peninsula in his map of the range of the species, the writer can find no recorded localities nearer than Oneida County, Wisconsin,[2] and the north shore of Lake Superior. Northern Michigan has probably been included in the range because this region formed a part of the "Northwest Territory"; it is not included by Merriam.[3]

The museum is indebted to the U. S. Biological Survey for verifying the identification of the specimens mentioned, and to Professor W. B. Barrows, for the loan of the specimens in the Michigan Agricultural College.

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INTERGLACIAL RECORDS IN NEW YORK

IN Professor H. L. Fairchild's most interesting address on "Pleistocene Geology of New York State" the following statement appears:[4]

> The accepted facts of multiple glaciation in the Mississippi basin coupled with proofs of Prewisconsin drift in Pennsylvania and New Jersey and on Long Island, with accumulating evidences in New England, demands the theoretical acceptance of at least dual glaciation for New York state. But the positive proof, in the field, of a Prewisconsin ice sheet has not been found.

A few years ago, Miss Maury[5] reported an interglacial deposit at the south end of Cayuga Lake, on the west shore between "Taughannock Falls and Frontenac Beach in a small ravine which has cut through one of the delta terraces so common in Cayuga Valley." An exposure gave the following vertical section:

Drift	20 to 30 feet.
Gravel and sand	several inches.
Fossiliferous clay	10 to 15 feet.
Bowlder clay	10 to 15 feet.
Devonian shales	10 feet above lake level.

The lower bowlder clay is thought to represent the Illinoian invasion and is oxidized, indicating a period of exposure to the air and hence of erosion. The lower deposits are peaty and contain a quantity of plant remains. The upper fossiliferous deposits are a slaty blue clay in which mollusks to the number of eighteen species are found in abundance. Twelve of these molluscan species are also found in the interglacial Don beds of Toronto, and the lake in which these animals lived was doubtless contemporaneous with the large Ontarian Lake in which the Don mollusks lived. The thickness of the clay deposits (10–15 feet) indicates a long period of deposition.

In the Watkins Glen-Catatonk Folio of New York,[6] page 26, reference is made to an older drift in Watkins Glen, underlying 100 feet of Wisconsin drift. In the blue clay underlying the drift and overlying a bed of sand and gravel, the leaf of an arctic willow (*Salix reticulatus*) was found. Though this deposit is stated by the authors to have probably been laid down during the advance of the Wisconsin ice sheet, the inference is strong, in view of the Cayuga Lake and the Toronto interglacial deposits, in favor of its being contemporaneous with the Scarboro beds near Toronto which contain cold climate animals and plants, including an undermined willow (*Salix* sp.). The evidence of this Cayuga Lake deposit appears to be quite as conclusive as is that of the Toronto deposits.

[1] "Life Histories of Northern Animals," Vol. II., p. 1107.
[2] Hartley H. T. Jackson, *Bull. Wisconsin Natural History Society*, 1908, pp. 30–31.
[3] "North American Fauna," No. 10, p. 48.
[4] SCIENCE, XXXVII., No. 946, p. 238.
[5] *Journal of Geology*, XVI., pp. 565–567, 1908.
[6] Geologic Atlas, No. 169, 1909.

It is quite probable that well records in western New York will supply additional interglacial records as has been so abundantly done by the well records of Minnesota, Iowa and Ohio. The records in New York state referred to above, while few in number, are still of a character to supply indubitable proof of a Prewisconsin ice invasion in this territory.

During the work of compiling literature relating to the life of postglacial and interglacial deposits, it was observed that little or no attention had been given by New York geologists to the fresh-water life of the ancient lakes of the Champlain substage. The gravels of the Niagara River[4] and certain deposits at Ithaca[5] appear to be the only localities from which life has been definitely reported. Many years ago Hall[6] reported *Unios* and wood from the ridge bordering the south side of Lake Ontario, which marks the shore of the glacial Lake Iroquois. A careful study of this old beach and especially of bays or lagoons behind the beach proper will surely produce results similar to those obtained by Professor Coleman at Toronto.[7]

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The Production in Kittens Inoculated with Entamœba Tetragena of Pathological Forms Identical with Entamœba Histolytica

To the Editor of Science: Schaudinn stated that the reproduction of *E. histolytica* by sporulation "occurs after a period of lively increase when the conditions of life have deteriorated. In dysentery this is simultaneous with the commencement of healing."

I have been able recently by the rectal inoculation of a succession of kittens with trophozoites of *E. tetragena* to observe during a "period of lively increase" the adolescent trophozoite gradually become reduced in size and to note the production of chromidia in large amount in every individual. This appeared first in the third remove as fine particles in the cytoplasm. In the fourth remove, collections of large particles were seen. The nucleus took on the characters of *E. tetragena, i. e.,* prominent karyosome, and at the time of death of the last set of kittens in the fourth remove, typical *tetragena* cysts were seen, but associated with them were forms in which bizarre appearances identical with those figured by Hartmann from Schaudinn's *histolytica* preparations were seen. These are certainly manifestations of pathological cell changes, and represent dislocations of the nucleus, karyorrhexis, karyolysis and extrusion of the nucleus. Many so-called buds were seen, a number of which had become detached from the parent body after the extrusion of chromidia. This budding process seems to be analogous to certain pathological changes in the cytoplasm of mononuclear metazoan cells, for example, in lymphocytes and plasma cells.

The production of budding and other pathological forms identical with the descriptions and drawings of *E. histolytica*, but produced in kittens in a senile precysting race of *E. tetragena* associated with typical *tetragena* cysts indicates almost certainly that *E. histolytica* is a spurious species, having been described by Schaudinn and Craig from senile races of *E. tetragena.*

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Ancon Hospital

Indoor Humidity

To the Editor of Science: In view of the present-day discussion of the subject of indoor humidity some experiments recently carried out by the writer may be of interest to those who, like himself, have been bothered by the bugbear of the "70 per cent." which seems to be the optimum value according to most authorities.

Inside the casing of the hot-air furnace, and right on the dome or hottest part of the firebox, was placed a cast-iron pan with bottom shaped to fit closely. By a simple automatic device connected with the plumbing this was kept full of water, which was found

[4] Letson, *Bull. Buf. Soc.*, N. S., VII., pp. 238–252, 1901.
[5] Tarr, *Journ. of Geol.*, XII., p. 79.
[6] "Geology of New York," Part IV.
[7] *Bull. Geol. Soc. Amer.*, XIV., pp. 347–368.

to boil vigorously in all but the mildest winter weather. When this was supplemented by a crescent-shaped pan on the "radiator" (also inside the casing) the evaporation reached twenty-five or more gallons a day—this in a house of perhaps 20,000 cubic feet capacity.

A number of observations of the relative humidity were made with a sling psychrometer in both mild and severe weather. The effect of this considerable evaporation was to raise the humidity perhaps 15 per cent. above the 25 per cent. or 30 per cent. which is its winter value in most houses in this climate. When the value exceeded 40 per cent., however, very annoying condensation effects were noticeable; even the double windows were drenched with water, while, with zero weather outside, the baseboards and furniture of bedrooms which had been cold during the night were wet. At 50 per cent. the condensation became unbearable, even the walls—although built with double air space—being wet. With the humidity at 40 per cent., however—and it seldom exceeded this value with the above mentioned evaporation—no bad effects were noticeable, while it has certainly added very materially to the comfort of indoor living and possibly contributed in securing immunity from colds.

In conclusion it seems to the writer that considerable effort is required to raise the humidity even a few per cent., but that this effort is nevertheless well worth while; also that 40 per cent. is as high a humidity as can be obtained in this climate in winter without annoying condensation effects, even in a house with double walls and double windows, while 70 per cent. would mean the atmosphere of a steam laundry.

L. R. INGERSOLL

MADISON, WIS.

SCIENTIFIC BOOKS

Le problème physiologique du Sommeil. By HENRI PIÉRON. Paris, Masson et Cie. 1913. Pp. xv + 520, six figures in text.

This volume makes a notable contribution to the large literature bearing upon the nature and cause of sleep. That the subject is treated in a comprehensive manner is indicated by the headings of the six parts into which the book is divided, namely, the biology of sleep, under which is included a discussion of related conditions in plants and animals; the physiological phenomena characteristic of sleep, the treatment here being limited to the characteristic sleep in man and the mammalia; states analogous to sleep, including such conditions as coma, narcosis, the action of hypnotics, hypnotic and electrical sleep and hibernation; experimental observations upon the factors of sleep; theories of sleep, and lastly a summary of the present state of the problem together with an outline of his own views upon the subject. The bibliographical and critical part of the book seems to be complete and well done. The author quotes a very extensive literature, and, so far as the reviewer can determine from his own knowledge of the subject, the material referred to has been treated with great fairness to the authors concerned. In fact the impartiality and completeness shown in the presentation of the numerous facts and theories ought to make the book an especially valuable source of information for all who are interested in the subject.

Outside this feature interest attaches chiefly to the experimental contributions made by the author and to the theory which he is led to adopt. His own work, done in collaboration with Legendre, consisted mainly of a study of the toxines produced in dogs kept from sleep during periods varying from 30 to 500 hours. In these animals he obtained evidence of the production of a hypnotoxine which he was able to detect in the blood, brain and cerebrospinal liquid. Incomplete efforts made to isolate this body indicated that it is not dialysable, that it is destroyed by heating to 65° C. and that it is precipitable by alcohol and can be redissolved in water. In the animals subjected to insomnia histological examination demonstrated that there was a distinct degenerative change in the cortex of the prefrontal region. The cells were diminished in

size, the nuclei showed displacement and as regards the Nissl granules there was a condition of chromatolysis or achromatosis more or less complete. When the serum or cerebrospinal liquid from one of these animals was injected into the fourth ventricle of a normal dog this latter animal in a short time gave evidence of somnolence, more or less marked, and upon histological examination showed in the cerebral cortex degenerative changes of the same character as those described for the animal suffering from insomnia. On the basis of these and similar observations the author believes that he has demonstrated the formation during the waking condition of a toxin which may be supposed to have a direct effect in the production of natural sleep. As it accumulates it provokes a condition of fatigue or diminished irritability in the sensory-motor apparatus of the central nervous system, which under the usual conditions may pass into normal sleep. In cases of prolonged insomnia the greater accumulation of the toxine may lead to the production of distinct lesions in the cortical cells and finally to death. When the author comes to apply this idea to an explanation of the mechanism of the daily sleep he encounters a number of theoretical objections which are enumerated and discussed with commendable frankness. The fact that seems to him to be the most difficult to harmonize with his theory is the abruptness with which sleep may appear and disappear. On his view of a gradual intoxication of the nerve cells he admits that there should be a progressive development of somnolence as the toxine gradually depresses the activity of the nerve cells. In view of this difficulty he feels obliged to call upon a secondary hypothesis, suggested by the general views of Brown-Séquard, according to which the hypnotoxine under usual conditions does not paralyze or inhibit the cortical cells directly, but exerts its action indirectly by putting into play an inhibitory nervous mechanism of unknown nature which suspends reflexly the activity of the cells. The reader who follows the author's presentation of the positive results of his experiments, with an increasing conviction that here at last has been discovered a definite factor destined to throw light upon the causation of this mysterious daily rhythm, is conscious of a distinct feeling of disappointment when he is asked to accept this unattractive hypothesis of an intermediary inhibitory apparatus. One can only conclude that the author has made another addition to the long list of unsatisfactory theories of sleep. However, we must feel grateful to M. Piéron for an apparently very reliable presentation of the difficult literature of the subject, and for the experimental results which indicate that during insomnia a definite toxic material is formed in the body. It is to be hoped that his findings in regard to this hypnotoxine will be corroborated and extended by other observers, although it must be confessed that the experimental procedure involved in the production of long-continued insomnia is of such a character that few investigators are likely to be attracted to the work.

W. H. Howell

The Mosquitoes of North and Central America and the West Indies. By Leland O. Howard, Harrison G. Dyar and Frederick Knab. Volumes 1 and 2. Washington, D. C., Carnegie Institution. 1912. Published January and February, 1913.

Nearly thirty years ago I heard Cobbold, the well-known authority on parasitism, lecture on *Filaria sanguinis-hominis* and its relation to the mosquito. It was a good lecture, and created a profound impression; but we who discussed the marvel at that time little imagined what still remained hidden behind the curtain, the merest corner of which had been lifted. In those days the Culicidæ, whether regarded from the medical or entomological point of view, were supposed to be relatively unimportant. To-day it seems astonishing that we could have been so ignorant, and yet all the work that has been done is very far from exhausting the subject. In April, 1902, Dr. L. O. Howard applied to the Carnegie Institution of Washington for a grant "which should enable the preparation

of a monograph to include all possible information concerning all mosquitoes" of North and Central America and the West Indies. It was at first expected that the work could be completed in three years, and the grants made covered that period. At the end of that time, however, the work was considered still too imperfect to publish, and was continued for several years more with funds derived from other sources. We now have before us only part of the work, namely, the volume covering the subject in a general way, with a discussion of its medical aspects, and the volume of plates. The descriptions of the genera and species, with detailed information as to distribution and other matters, will follow at some later date.

To those who are not specialists in entomological taxonomy, the first volume is of course by far the most interesting and important, though the later parts will contain a larger proportion of original matter, and will bring out most clearly the great advances made in our knowledge of the Culicidæ by the authors. One's first impression on taking up the first volume is that of wonder at the space needed (520 pages) for what is, after all, a general introductory discussion. On perusing the separate chapters, we are inclined to change our attitude, and marvel rather that it has been possible to treat of so many important topics in a single volume. Then again, our first naïve astonishment that so much is known about mosquitoes gives way to a profound sense of the great amount there is yet to learn. The monograph is "complete" in the sense that it apparently includes all the important available information bearing upon its topic, but almost every chapter suggests to the mind of the reader numerous possible interesting researches. Thus the book is one of those live ones which will, as the result of one of its merits, soon become more or less out of date.

Modern science demands the publication of works which are too expensive and of too broad a scope to be, except in rare instances, prepared by a single man. Thus the mosquito monograph, due to three authors, and containing in addition extensive quotations from many others, stands as a type of the scientific monographs (if the word may still be allowed!) of the future. Prepared by men who are thoroughly familiar with the subject, having contributed many more new observations than any others in this country, it is very far from being a mere compilation; yet there has been no hesitation in compiling from the best sources in every case, with full credit given and usually the exact words of the writers cited. All this involves a certain sacrifice of ostensible originality, but it is much to be preferred to the method of many writers of general works, who, on the plea of uniformity of treatment, undertake to discuss subjects they do not understand, and in using other writings make all sorts of blunders. In the present instance the authors distinctly state that they are "entomologists and not physicians or medical investigators," and so the chapters dealing with medical matters "are not the result of original investigation," although it is well known that the senior author is an expert on medical entomology.

Following the Introduction is a chapter headed Early Accounts of Mosquitoes, which includes among other things a long and interesting quotation from Humboldt. The structure of the mosquito is discussed in about 80 pages, including the immature stages as well as the adult. Standard descriptions are quoted from Child, Dimmock, Kellogg, Nuttall and Shipley, Snodgrass, J. W. W. Stephens, Christophers, Raschke, Hurst, Eysell and others; but the original observations of the authors are more interesting than any of these, since they alone know enough species to give a good *comparative* account. So much that is significant appears from the comparative study of the different organs of various Culicidæ, that there is evidently a splendid field for further research along the same lines, especially in reference to the internal organs. When the taxonomic volume appears, it will no doubt be possible for workers in any part of the country to readily and accurately determine the species they may use in such studies.

The habits of mosquitoes, adults and young, are treated in 50 pages, followed by a detailed account of their natural enemies. This last topic is evidently capable of great extension, and it is evident that any intelligent amateur can readily add to what is known by observations in his own locality. The relation of mosquitoes to man occupies about 260 pages, covering both theoretical and practical aspects. The very clear and well written, but not in the least sensational, accounts of the discovery of the connection between mosquitoes and malaria and yellow fever ought to be reprinted and distributed broadcast over the country. Some bulletins of the Department of Agriculture give useful practical information about mosquitoes and disease, and there are various other more or less accessible publications dealing with these matters; but would it not be a good thing if the plain, unvarnished, historical account of the work of Manson, Ross, Grassi, Finlay, Reed, Carroll and Lazear (and we should like to add portraits of these men) could be sent, in the form of a pamphlet, to every school in North America? We offer the suggestion to Mr. Carnegie. To this account might be added the words of the authors, who after describing brilliant anti-malarial work in foreign countries, are obliged to say: "In the United States, it is sad to relate, almost nothing has been done in the way of an active campaign against malaria alone, even in restricted localities. It is true that extensive work has been done against mosquitoes, but in the most of these cases the incentive does not seem to have been to better the health of the people or to stamp out malaria." The volume ends with a bibliography and a very complete index.

The second volume contains 150 beautiful plates, illustrating the structural characters of the eggs, larvæ, pupæ and adults. In a work otherwise characterized by such conscientious crediting of all assistance, it is surprising to see no reference to the artist or artists of the plates; doubtless this information will be given in the next volume.[1] We note that in the names of species, no attempt is made to alter the terminations of adjectival specific names to make them agree in gender with the names of the genera to which they are referred.

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Trees in Winter: their Study, Planting, Care and Identification. By Albert Francis Blakeslee, Ph.D., Professor of Botany and Director of Summer School, Connecticut Agricultural College, and Chester Deacon Jarvis, Ph.D., Horticulturist, Storrs Experiment Station. Illustrated Octavo, 446 pp. New York, The Macmillan Company. 1913.

About a year ago the writer of this review had the pleasure of making a short notice[1] of Bulletin 69 of the Storrs Agricultural Experiment Station, entitled "New England Trees in Winter" by the authors of the work now under consideration. Then we said "We do not recall any better treatment of our trees than is to be found in this publication." Further use of the bulletin confirms the favorable impression made on its first appearance. We have now a very considerable enlargement and revision of the bulletin in the form of the stout volume whose name appears at the head of this review. In revising the earlier publication the authors have introduced chapters on the structure, life and growth of trees, their propagation, tree planting in the country and the city, how to plant, care, common injuries, control of parasites, insecticides, etc. In these chapters the authors have managed to condense a great deal of valuable information for the general reader, and especially for the owner of a piece of ground on which trees are now growing, or on which the owner wishes to plant trees. Nor do they present the growing of trees merely from the standpoint of utility, although that is sufficiently empha-

[1] I have since learned that the drawings of whole larvæ and the detail drawings of larvæ (plates 86–131) are by Mr. Knab, part of the latter inked in by Miss Mary Carmody. The male genitalia are drawn by Miss Carmody; the eggs (plates 146–147) are by Miss E. G. Mitchell. The photograph of *Anopheles* wings is by Mr. H. S. Barber.

[1] Science, March 22, 1912.

sized. We like the opening sentences in Chapter III., and can not refrain from quoting some of them, as follows:

> Every citizen in every country is interested, or should be interested, in good scenery. Of the various elements that constitute good scenery or that go to make up our landscape there are none so ornamental nor so indispensable as trees.
>
> In discussions relating to the conservation of our natural resources, therefore, the element of good scenery should always be considered. Since good forests, good farms and good waterways contribute largely to the landscape, the element of good scenery can not easily be separated from many of the commonly recognized natural resources.
>
> Trees have become so much a part of our civilization that it would seem almost impossible to get along without them. What would our homes, our country roads, our city streets, our parks, and our landscape be without them? We all know that trees are beautiful and even necessary in such places, but we can not fully appreciate their value till we have seen the desert.
>
> The value of trees from the economic or commercial standpoint is well understood and can be estimated on the basis of dollars and cents. Their esthetic value and their value from the standpoint of health is not so generally appreciated nor is it so amenable to calculation. We hear a great deal these days about surveys—forest surveys, agricultural surveys and the like. A survey in this sense means an inventory or a stock-taking. It would be interesting to make a survey based upon the landscape wealth of any section or of the whole country. It would be interesting also to compare in such a survey the relative value of the various elements of the landscape. It seems safe to predict that in most sections trees would be credited with a very large proportion of the total wealth.

And again in Chapter IV., we find these suggestive sentences:

> When we think of the open country we are reminded of the cool and shady roads, although some country roads are not so alluring as they ought to be. The thought is comforting. On the other hand, when we think of conditions in the city, the hot and dazzling pavements present themselves vividly to our memory. The thought is anything but comforting. Blessed is the city that is well supplied with trees.
>
> The attractiveness of a city depends largely upon its trees. A city without trees can not be attractive, and the more trees within the city limits, the more attractive is the city likely to be.

Passing to the systematic part of the book there is first a general chapter on the identification of trees, with such explanation of terms as will render this work easier for the beginner. Then follow various keys, as (1) a key to genera, (2) keys to the conifers, (3) keys to the various kinds of deciduous trees. These keys refer to full-page descriptions and discussions of the particular species, and on the opposite page is a full-page plate of characteristic illustrations made by "half-tone" process from carefully selected photographs. These descriptions cover habit, bark, twigs, leaves (in evergreens only), buds, fruit, comparisons with other species, distribution, and wood characters. Preceding the descriptive matter is an English name, followed by the scientific name, very properly in a book like this, accompanied by the "authority" for the species. A convenient glossary and a well arranged index complete this useful book. The binders have enclosed the text in a pretty and appropriate cover in keeping with its title.

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Science and the Human Mind, a Critical and Historical Account of the Development of Natural Knowledge. By WILLIAM CECIL DAMPIER WHETHAM, M.A., F.R.S., Fellow and Tutor of Trinity College, Cambridge, and CATHERINE DURNING WHETHAM, his wife. New York, Longmans, Green, and Co. 1912. Pp. xii + 304. Price, $1.60 net.

This work consists of an Introduction, and of six chapters on Science in the Ancient World, the Medieval Mind, the Renaissance and its Achievement, the Physics of the Nineteenth Century, the Coming of Evolution, and the Last Stage; of a good bibliography (pp. 287–296), and of a full index. The authors are already known favorably to scientific men by their "A Treatise on the Theory of Solution" and "The Theory of Experimental Electricity"; to the general public by their admirable "The Recent Advance of Physical

Science"; and to students of society by several publications on heredity and eugenics. In other words, they have proven their right to the present undertaking by substantial contributions to at least two distinct fields of research.

It is obvious, of course, that a field so vast can not be covered satisfactorily in a single volume of moderate size. Accepting this limitation as inevitable, and setting aside criticisms which, unmindful of it, one might pass readily, it may be said at once that the effort is remarkably successful. Indeed, I am unacquainted with a better book, particularly in the matter of unexpected suggestiveness (towards the close notably), of equal or briefer compass. I would commend the spirited, sometimes eloquent picture of the medieval mind (pp. 64 f.), the lucid account of Newton (pp. 128 f.), the absorbing tale of the rise of electrical science (pp. 181 f.), the generous tribute to Darwin (pp. 209 f.), and the last chapter (pp. 233 f.), which is, in itself, enough to justify the book. It is a pleasure to meet devotees of "natural knowledge" who not only can write, but evince sane appreciation of humanistic knowledge.

The blots are few. Here and there, especially in the Introduction and on the last page, the authors permit themselves to be betrayed into what I take the liberty to call silly remarks about philosophy and metaphysics. Plainly, their *Wissenschaft* knows not these subjects as *Wissenschaft*. This is the more striking that, in other contexts, they make most ample amends. I mention this, because it punctuates the contrast between themselves and Dr. Th. Merz, with whom they are likely to be compared. They may feel his catholicity, they do not always observe it.

The race-theory, a result of their sociological inquiries, which Mr. and Mrs. Whetham apply to their subject, is one of the fascinating features of the book. "Natural knowledge" has been formulated and developed by the races of northwestern Europe. "It is possible that danger to science, as to society, lies ahead. . . . The dominance of the universal proletariat, which some dread and others acclaim—a proletariat not dissimilar in race to the southern rulers of the Roman Church—may threaten in the future the freedom of enquiry, the fearless exercise of reason, the full development of personality, that form the life-blood of the northern race and its scientific achievement. . . . If the same race once more gains ascendancy in northern lands, as, by the differential birth-rate and the downward shift of political power, it seems destined to do, it is difficult to believe that scientific results which threaten its prejudices or are not in accord with its ideals will be respected" (pp. 279–80). Darwin was a conspicuous product of the Anglo-Danish and East Anglian folk, who have done most for the progress of science. And so, Mr. Whetham is able to construct a great brief for his own, the East Anglian, university. Nevertheless, I do not see why he should have omitted Macquorn Rankine in reference to the foundation of thermodynamics (p. 179). Nor does his theory, of the mysticism of the northern race, supply the reason why Kelvin "is said to have begun his lectures on physics with the Collect for the day" (p. 158). As a pupil, I may say that Kelvin did so, but because it was the universal custom at Glasgow to open the morning classes with prayer. Nevertheless, I accept the theory, as indeed I must—my paternal ancestors for generations are East Anglians! And yet, I am in doubt; for I still traffic in "speculative philosophy, tossed about by every wind of doctrine" (p. 7). But, it were too hard a test to ask an author to prove his theory on the *corpus vile* of a reviewer of whom he never heard tell. So, once more, I say the book is thoroughly worth while.

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NOTES ON ENTOMOLOGY

The eleventh volume of the Hampson catalogue of moths has been issued by the British Museum.[1] It deals with four groups—Ente-

[1] "Catalogue of the Lepidoptera Phalænæ in the British Museum," Vol. XI., pp. 689, text figs. 175, pls. CLXXIV.–CXCI., 1912.

lianæ, Stictopterinæ, Sarrothripinæ, and Acontianæ, which include nearly 1,000 species arranged in about 150 genera. They are mostly from tropical countries.

ONE of the most interesting series of books is that on the fauna of India. A recent volume by Canon Fowler on the beetles is especially attractive because of the general account of the Coleoptera.[2] There is a discussion of the several recent classifications of Coleoptera, the author using, although hardly accepting, three principal divisions, Adephaga, Polycerata and Lamellicornia. The essential characters are given for each family, 103 of which are recognized by Fowler, and a short account of their habits, larvæ, distribution and peculiar forms. A glossary of technical terms used in Coleoptera is also included. In the main part of the work the Indian tiger beetles are fully described and many illustrated in text figures. The part on the Paussidæ includes a summary of their habits, and the little known about their larvæ. The Rhysodidæ and Cupedidæ are also treated in this volume, each with only a few species.

OF all the peculiar termitophilous insects the Histerid beetle recently described by Dr. E. Mjöberg will easily rank as the most remarkable.[3] It is a native, of course, of Australia. There are two tufts or pencils of long, curved hairs arising from each side of the base of the elytra. The termites gather a secretion from these hairs, but it is not known whether the secretion comes from the hairs. The insect is named *Eucurtia paradoxa*.

THE value of minute structures in classification is well illustrated by an article on the classification of the bed bugs by Dr. K. Jordan and N. C. Rothschild.[4] They divide the family into three subfamilies on the nature of certain bristles, whether serrate on certain portions or not. The Clinocorinæ includes *Clinocoris* and *Œciacus;* the Cacodminæ includes *Cacodmus, Loxaspis* and *Aphrania,* and the Hæmatosiphoninæ the one genus *Hæmatosiphon*.

THE life habits of structurally peculiar insects are apt to be unusual, and Dr. F. Germer has found this true of the Lymexylonidæ.[5] The adult does not feed, but the larvæ apparently feed on a fungus that grows in their burrows. The author illustrates the peculiar structures of antennæ and palpi in various sensory functions.

DR. A. DÜCKE has published a revision of the South American genera of bees.[6] He gives a bibliography of South American bees since Dalla Torre's catalogue, a synopsis of the sixty-eight genera known from the region, the geographical distribution of each genus, in some cases a list of the described species, and descriptions of a few new forms.

PROFESSOR T. MIYAKE has given the most complete account, so far, of the life history of a Panorpid.[7] The eggs are deposited in clusters of from six to ten in crevices in the soil. The larva of the Japanese species is similar to that of the European and American species already figured. They probably pass through seven molts, the perforations in the spiracles increasing in number with each molt. The larvæ feed on dead insects. There are two broods in a year. The adults were observed to feed on dead insects and the petals of a flower. None have been observed catching living insects.

DRS. J. SCHNABEL and H. Dziedzicki have produced a most important work on the

[2] "The Fauna of British India, including Ceylon and Burma," Coleoptera, I., General Introduction, Cicindelidæ and Paussidæ, 529 pp., 240 figs., London, 1912.

[3] "On a New Termitophilous Genus of the Family Histeridæ," *Ent. Tidskrift,* 1912, p. 121–124, 1 plate.

[4] "Notes on the Clinocoridæ, a Family of Rhynchota, with Descriptions of a New Genus and Species," *Novit. Zool.,* 1912, p. 352–356.

[5] "Untersuchungen über die Bau und Lebensweise der Lymexyloniden," *Zeitschr. wiss. zool.* (1), Bd. 101 (1912), pp. 683–785, 2 pls., 31 text figs.

[6] "Die natürlichen Bienengattungen Südamerikas," *Zool. Jahrb.,* Abt. Syst. XXXIV., p. 51–116, 1912.

[7] "The Life History of *Panorpa klugi* McLachlan," *Journ. Coll. Agric. Imp. Univ. Tokyo,* IV., No. 2, pp. 117–139, 2 pls., 1912.

Anthomyidæ.[8] It is a critical revision of the genera of the family, with especial consideration of the male genital apparatus, and all the plates represent hypopygia or lobes of the fifth ventral segment. The authors consider the family in the sense of Girschner, including most of the Muscidæ. In the supplementary part are descriptions of many new species, mostly from Russia.

The progress of entomology in South America is unfortunately slow, and for this reason we welcome each new elementary treatise from that quarter as an encouragement for the local naturalists to collect and study their insects. A new work of this character is by Dr. C. E. Porter on the Myriopods of Chili.[9] He gives an illustrated account of the structure and habits of myriopods, and follows with an annotated list of the 64 species so far described from Chili. Many of the genera are different from those of our country, and several are peculiar to Chili.

The anatomical part of the 34th (1912) volume of the *Zoologisches Jahrbücher* is more than ordinarily occupied by entomological articles. Mr. Edw. Schoenemund gives a descriptive and biological study of the larvæ of the three large European Perlas,[10] with notes on the anatomy of the respiratory and digestive systems, and the development of the sexual organs.

Mr. S. Surlov has an article on the salivary glands in the head of some Orthoptera, especially *Mantis*[11] and their relation to similar glands in Myriapoda.

Dr. H. Mammen gives a comprehensive study of the comparative morphology of the stigma in various Hemiptera,[12] both in Heteroptera and Homoptera. He finds that in most Hemiptera there is but one muscle to each stigma whose contraction closes the slit, but in a few forms, two or three muscles occur.

Dr. W. Baunacke has a long article on the sense organs of certain aquatic Hemiptera of the family Nepidæ.[13] These organs on the venter are considered to be organs of orientation.

Mr. E. Foerster gives the results of a study of the comparative anatomy of the sting of various ants,[14] and traces the homologies.

Nathan Banks

[8] "Die Anthomyiden," *Abh. Kaiserl. Leop.-Carol., Deutsch. Akad. Naturf.*, XCV. (No. 2), pp. 55–358, 35 pls., 1912.

[9] "Introduccion al estudio de los Miraopodos," Santiago, 1911, 68 pp.

[10] "Zur Biologie und Morphologie einiger Perla-Arten," pp. 1–56, 2 pls.

[11] "Uber die Kopfdrüsen einiger niederen Orthopteren," pp. 97–120, 3 pls.

[12] "Ueber die Morphologie der Heteropteren und Homopteren-stigmen," pp. 121–178, 3 pls.

[13] "Statische Sinnesorgane bei den Nepiden," pp. 179–346, 4 pls.

[14] "Vergleichend-anatomische Untersuchungen über den Stechapparat der Ameisen," pp. 347–380, 2 pls.

SPECIAL ARTICLES

PALMESTHETIC BEATS AND DIFFERENCE TONES[1]

In publishing the results of my experiments on palmesthetic difference sensibility,[2] I did not take up the question whether the discriminations with which we were dealing were of rates of succession of discrete sensations, or of differences in the characters or quasi-characters of continuous sensations. That this question must be raised is of course obvious, since the vibration-rates of the forks I employed (between four and five hundred vibrations per second), are below the fusion limit as reported by Valentin,[3] von Wittich,[4] Schwaner[5] and others. The results of Preyer,[6]

[1] From the Psychological Laboratory of the Johns Hopkins University.

[2] Dunlap, K., "Palmesthetic Difference Sensibility for Rate," *Amer. Jour. of Physiol.*, XXIX., 108–114.

[3] Valentin, "Ueber die Dauer die Tasteindrücke," *Arch. f. Physiol. Heilk.*, XI., 438.

[4] Von Wittich, "Bemerkungen zu Preyer's Abhandlung über die grenzen des Empfindungsvermögens und Willens," *Pflüger's Archiv*, II., 329.

[5] Schwaner, "Die Prüfung der Hautsensibilität vermittelst Stimgabeln bei gesunden und Kranken," Inaug. Diss., Marburg, 1890.

[6] Preyer, W., "Die Grenzen des Empfindungsvermogens, etc.," 1868, 15.

Lalanne[7] and Mach,[8] giving the fusion limit far below the range I employed, throw doubt on the other results, and make it evident that there is somewhere in the determination a factor which has escaped attention by one group or the other of the experiments, or possibly by both.

The early observations were made with little reckoning of the troublesome psychological problems involved, and with no reference to the possibility which we must at present admit—that vibratory stimuli applied to certain portions of the skin may rouse sensations other than those of pressure, touch, temperature or pain: sensations of vibration, or palmesthetic[9] sensations, as they are provisionally designated. The former point we will consider below; the latter is of prime consequence.

If an observer assumes that when a tuning fork (the stem of it or some attachment to a prong) is applied to the skin the sensation aroused will be either that of mere continuous touch or pressure (we may leave out of account pain and temperature, as being easily discriminated from the other), as when the fork at rest (not vibrating, that is) is applied; or else of the discrete series of touches corresponding to the individual periods of the vibration, his observational problem will be comparatively simple. If the fork is perceived as being in vibration, the judgment will be "*discrete pulses*," or "series of discrete tactual sensation"; if the fork feels as if not vibrating, the judgment will be "*fusion*." In other words, the problem of observation is restricted to the question whether or not the fork can be perceived to be in vibration. This, we may reasonably infer, was actually the problem as understood by a number of the experimenters, and consequently the thresholds of fusion they reported were limited simply by the mechanical capacity of the forks (or whatever serial stimulation devices were employed) to produce a sufficiently intense vibratory stimulus.

When we admit the possibility that the vibration of the fork may produce a sensation which is not identical with the simple touch or pressure sensation, the problem becomes entirely different. It is now a question of determining the point (in rapidity of stimulus) at which the sensation enters, or the point at which it becomes a continuous sensation; or possibly we may have to make both determinations. That there are abundant clinical observations which go to show the existence of a palmesthetic sensibility not identical with touch or pressure, I pointed out in my first paper.

The forks with which I first worked (in the neighborhood of 440 vibrations per second) were too heavy for their length, and the vibration-feeling consequently feeble and of brief duration. I have since secured some forks which are better adapted to the work, being relatively more slender, and have carried on observations with these. They have prongs approximately 8×5.5 mm. in cross section, and 19 cm. long for c (128 per sec.) and 13 cm. long for c′ (256 per sec.). The c^2 forks of the same cross section, 9 cm. long, are less satisfactory. The forks have been fitted (by our mechanic) with tubular brass extensions to the stems, giving a total length from the crotch of 9.5 cm. The end of the extension is solid, with a diameter of 1 cm. Weights with clamp-screws are fitted to slide on the prongs so that the forks may be tuned from the original c and c′ down to the F and f below, by any required steps.

These forks were prepared primarily for the purpose of determining difference-sensibility in the octaves represented. This work has not been completed, but shows, so far, about the same threshold as was earlier obtained in the middle octave (approximately 10 per cent.). The present report is not concerned with this measure.

We early noticed that beats were palmesthetically perceived, and were as distinct and characteristic as auditory beats. With properly tuned forks, we found differential sensa-

[7] Lalanne, "Sur la durée de la sensation tactile," *C. R. de l'acad. des sci.*, LXXXII., 1314.

[8] Mach, E., *Sitzber. d. Weiner Akad.*, LI., 2, 142.

[9] The term was introduced in German, by Rydel and Seiffer in 1903.

tions, corresponding to auditory difference-tones. In arousing these, the two fork stems were firmly pressed together, and the circular end of one stem pressed lightly against the skin of the border of the palm; or the subject's finger tips were pressed lightly against the fork stem.

Fearing lest the phenomenon might be some peculiarity of the action of the physical couple corresponding to the "objective" difference tone, certain auditory experiments were carried out, as follows. A König resonator was tuned to the difference tone of one of the forks; it of course gave no response when the vibrating forks were not in contact, and it still gave no response when the stems were pressed together. Pressing both stems against a block of resonant wood failed to make the resonator respond, although the wood was brought within a few inches of the orifice of the resonator. A single fork tuned to the difference-tone and resonator, pressed against the wood in this way, evoked a loud response from the resonator, even when the fork was vibrating feebly.

It occurred to me that the point (in the scale of rapidity) at which the beats passed into a differential sensation might give a measure of the lower limit of palmesthetic sensibility, and that in any case the determination of this point was important. Here the difficulties were encountered.

As only an approximate determination was desirable at this juncture, one of the c′ forks was scaled in the steps b, a♯, a, g♯, g, f♯ and f, certified forks being at hand for these rates, giving differences with the other c′ fork of 16, 33 +, 42 +, 56, 64, 78 + and 85 + double vibrations.

In my own case, the determination is fairly certain. The beats are distinctly perceptible down to c′–g (64). At c′–f♯ (78 +) this discreteness begins to pass into a sensation comparable to that of another fork (*i. e.*, a continuous sensation), and at c′–f (85 +) this new sensation becomes unmistakable and definite, the beats entirely disappearing.

With still greater difference, the differential sensation persists, becoming less and less intense, as is the case with the sensations aroused by single forks of increasingly higher pitch.

In the first day's work with W., a graduate student, the results were exactly the same as those obtained from myself and were invariable. A month later his results were radically different. He still observed the differential sensation as like that from a low fork, but claimed that it was a matter of discrete pulses, differing from the beats of smaller differences only in rapidity. In fact, he now claimed that the single-fork stimuli, even from the 512 fork, gave series of discrete sensations, and further claimed that the auditory stimulus from the same fork produced the same sort of discrete sensations, corresponding to the air pulses. It should be said that W. is unmusical, but is a good observer.

My own observations fit in quite well with those of W., as regards the palmesthetic sensations, although the auditory sensations (beyond 40 vibrations per second) are always sensibly continuous. With best attention, the palmesthetic sensation (beyond 85 per second), is as continuous as the auditory, but nevertheless at certain other times it seems to be a discontinuous series. In my observations, however, there is a clear indication of the reason for this discrepancy. In one case I am attending to the sensation as it is; and in the other case to the fork thought of as an oscillating body—to the representation of visual or muscular sort—rather than to the actual presented sensation. Such training as my palmesthetic sensibility has received during the greater part of my life has probably been in the way of interpreting the sensations in terms of the vibrations represented as movements of some body; hence, even when I should be attending to the sensation I still incline to attend to the meaning instead. A large number of individuals undoubtedly tend to treat vibration in this way.

In attending to sounds, the interpretative tendency is not so strong, as the conditions are not so conducive to training in this direction. The special significance of sounds as

indicating oscillatory movement is more remote, and more easily detached from the sensation. This detachment was difficult for W., in the case of the tuning fork, because it was for him principally an instrument for the inscribing of curves for time-measurement: the sound of the fork signified its motion in space, and the intensity signified the amplitude of the sinusoidal line it could trace. This observation was made by W. and reported in practically the words I have used.

The results of observations made by several other subjects give about the same threshold as my own observations. One graduate student, J., perceived no beats at c′–g♯ (56), obtaining perfect fusion at that point, although in auditory experiments the fusion was not complete until 64 was reached. This subject at no time had tendency to confuse the sensation and the motion. He is quite musical.

Another graduate student, B., reported that he was constantly troubled by the "visualization" of the tuning-fork curve. He perceived clearly the discreteness of the beats up to c′–f♯ (78+), but beyond that point was unable to decide whether the sensation was or was not continuous.

D., an undergraduate student with previous training in palmesthetic work, and in discrimination of rates and in certain other sorts of psychological observation, obtained clear fusion at c′–f♯ (78¼) and undoubted discreteness at c′–a (42⅜). Between these points, there was doubt, and variation in his judgments.

It should be noted that the differential sensation (above about 80) is perceived as exactly like that due to the addition of a third fork, even by subjects who judge it to be a matter of discrete phases. The problem is, therefore, not to decide as to the character of the differential sensation merely, but concerns any vibration of the same rate.

The differential, when faint, may be made perceptible in a way quite similar to that in which the auditory differential is brought out, namely, by stimulating with the lower of the two forks alone for a moment, and then adding the higher; the resultant drop in the pitch of the clang is paralleled by the corresponding change in the felt vibration.

In the tests described herein, the forks were not audible, they being weakly excited, and used at a sufficient distance from the subject's head—at arm's length. In fact, they were scarcely audible when brought up to half the distance from the head.

After making these observations, I am compelled to view with suspicion the results of any simple observations on the threshold of discreteness and fusion in the palmesthetic or haphic realms (and, indeed, in the auditory realm also). I include my own observations in this suspicion, along with others, for while I may say that my observations have been very careful, they can not do more than establish a presumption. Mere observation ("introspection" in the sense of the word now happily becoming obsolete) is productive of no certain results; the measurements I have been describing are excellent vehicles for the demonstration of the fact, and I strongly recommend them to any one who is inclined to rely on the results of simple observation. These observations are not experimental in the proper sense of the word; but fortunately it is possible to apply experimental methods to the problem upon which they bear.

The palmesthetic difference sensation can not be wholly without significance for the theory of auditory perception. Although I have a bias against the "telephone" theory, I must admit that the perception of a difference in vibration rate by dermal or subdermal nerves, and the detection of a differential rate by these same nerves, seems to support strongly the assumption that differences in pitch of sound are not essentially connected with differences in peripheral nervous elements, but that the same cochlear nerve terminations may mediate different pitches, and the same pitch be mediated by different terminations.

KNIGHT DUNLAP

ECHINODERM HYBRIDIZATION

IT is my purpose to call attention in this note to certain facts, the consideration of which may do something toward bringing

order out of the apparent confusion in which the subject of Echinoderm hybridization is involved.

I may preface my remarks by saying that actually no confusion exists. The apparent confusion is the result of too narrow and restricted a view of the facts, but the student of genetics whose attention has not been called in detail to the matter has no means of realizing that this is true.

In at least two published papers I have made in substance this statement:

> It is well known that an apparent confusion exists among observations on hybrid Echinoid larvæ, as to whether plutei of a maternal type, a paternal type or of mixed form are derived from certain crosses. Different results have been obtained by different investigators and by the same investigators working in different regions or in the same region in different seasons.

This statement was made after the consideration of the work of Boveri, Driesch, Morgan, Seeliger, Vernon, Doncaster, Herbst, Steinbrück and others, in connection with my own observations, extending at that time over a period of five years, which were based upon some fifteen successful crosses.

If further proof of the truth of the quoted statement be needed we have it in the results of Hagedoorn, who wrote in 1909 on the "Purely Motherly Character of the Hybrids produced from the Eggs of *Strongylocentrotus*," and of Loeb, King and Moore, who in 1910, after working on the same type of material, in the same region, reached the conclusion that the hybrids show neither a preponderance of paternal nor of maternal influence.

Again, Shearer, De Morgan and Fuchs in 1911 published a "Preliminary Notice on the Experimental Hybridization of Echinoids," based upon three years' study of three species of *Echinus*, in which they state the conclusion "that the inheritance of the late larval characters was invariably maternal." In 1912, after another year's work on the same forms they published in the *Quarterly Journal of Microscopical Science*, Vol. 58,

> To our surprise, however, the behaviour of some of the hybrids has differed greatly this season from that of previous years. In late larval life some of the hybrid crosses have shown as strictly a paternal inheritance as in previous years they have shown a maternal one.

It is perfectly evident then that the observations of these later students confirm the truth which I have been trying to establish from my own work, as well as urging that it had already been established by earlier investigators. I emphasize again then the fact that no actual confusion exists. It has been established again and again that under some conditions we may obtain larvæ of a maternal type with respect to certain characters, under other conditions larvæ of a paternal type and under still other conditions larvæ of a blended type. This is established. We should accept the fact.

The real problem in Echinoderm hybridization is the determination of the conditions under which these various types appear.

Another idea to which I wish to call attention is embodied in a statement in the summary of the Shearer, De Morgan and Fuchs 1911 paper:

> As the result of extensive investigation of the early larval history of our various crosses, we have come to the conclusion that these are too variable to afford any definite evidence of parental influence and especially is this true with regard to the skeleton, heretofore considered the chief index of inheritance.

This generalization from a few crosses should not be applied to all. I am very willing to admit the statement for the Shearer, De Morgan and Fuchs crosses. I can not admit it for some of my own.

In my investigation of the variation of Echinoid plutei I made a prolonged study of the skeleton of *Toxopneustes* plutei. I know what the variations in the skeleton under laboratory conditions are, and I determined these variations before drawing my final conclusions as to the character of the skeleton in hybrids. When the extent and nature of the variations in the skeleton have been determined it may well serve as one of the indices of inheritance in crosses.

Further than this, in proper material, pa-

ternal influence may be demonstrated in stages even younger than the pluteus. I am now able to show definite and clear-cut evidence of such influence in the early gastrula stage. This evidence will soon be published in detail, so I shall give it here only in summary.

The material from which this proof is gained was obtained in February, 1911, while I was working at the temporary station established by the department of marine biology of the Carnegie Institution in Montego Bay, Jamaica, British West Indies. The research involved the investigation of the normal development of *Cidaris tribuloides* and of the hybrids obtained by crosses between *Cidaris, Hipponoë* and *Toxopneustes.*

In its normal development *Cidaris* is unlike the modern Echinoids in that the primary mesenchyme is formed late, the cells arising 23–26 hours after the fertilization of the egg, from the inner end of the archenteron, which has pushed, by this time, well into the blastocœle. No mesenchyme cells appear during the blastula stage. In *Toxopneustes,* as is well known, the primary mesenchyme cells arise about 8 hours after the fertilization of the egg, at the posterior pole of the blastula and have passed into the blastocœle before the beginning of the invagination of the archenteron. A similar condition holds for *Hipponoë.*

In the *Cidaris* ♀ × *Toxopneustes* ♂ and the *Cidaris* ♀ × *Hipponoë* ♂ crosses, gastrulation begins in about 23 hours after fertilization, as in the straight fertilized *Cidaris* eggs, the process not being noticeably hastened by the use of the foreign sperm. The primary mesenchyme appears about one hour later, the cells arising around the base of the then very short archenteron, at the region of the lips of the blastopore.

The influence of the foreign sperm is thus clearly shown in the changed site of mesenchyme formation. Furthermore, it appears ontogenetically earlier in the hybrids than in the normal *Cidaris* larvæ.

In calling attention to these matters I do not wish to disparage in any degree the work being done by Shearer, De Morgan and Fuchs and the other British zoologists who have recently begun work in this field. Their work on the later stages is admirable. I do wish to plead against the acceptance of negative evidence as the basis for a positive generalization concerning the early stages in Echinoid crosses. Well-chosen material may give positive evidence.

DAVID H. TENNENT

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

AT the regular meeting of the Academy on February 3 and 17, the following papers were read:

Dr. C. H. Turner:[1] "Apparent Reversal of the Light Responses of the Common Roach."

Dr. LeRoy McMaster: "The Preparation and Properties of the Ammonium Salts of Some Organic Acids."

Dr. Leo Loeb: "Some Biological Aspects of Tumor Investigation."

Dr. Turner discussed a series of experiments conducted with the common roach (*Periplaneta orientalis*) for the purpose of seeing if a negatively phototropic animal could be trained to refuse to enter a specific dark place; and, if that proved possible, for the additional purpose of obtaining an experimental analysis of the behavior.

The electrical punishment method, devised by Professor Yerkes in his study of the dancing mouse, was used.

The speaker stated that he had trained roaches of both sexes and different ages to avoid a specific dark place, and insisted it was equally as logical to interpret his results by concluding that the roach, by means of associated memory, had learned to avoid a specific dark place, as to term its behavior a reversal of negative phototropism.

Professor McMaster described a method of preparing the neutral ammonium salts of monobasic and dibasic organic acids, by dissolving the acids in absolute alcohol or ether and passing dry ammonium gas into the solution. There easily resulted the neutral ammonium salts of succinic, tartaric, ortho- and meta-phthalic, propionic, isobutyric and benzoic acids. Malonic, malic and cinnamic acid salts resulted with difficulty. Analyses showed the compounds to be neutral.[2]

[1] *Biological Bulletin,* Vol. XXIII., 1912, pp. 371–386.

[2] This paper will appear in the April number of the *American Chemical Journal.*

Dr. Loeb pointed out that Weismann's statement that the somatic cells of Metozoa are mortal is not warranted by the facts, the evidence leading merely to the conclusion that somatic cells can usually not reproduce the whole organism. In 1901 Dr. Loeb himself first announced that facts established through experimental tumor investigation made it very probable that tumor cells are potentially immortal, as much so as Protozoa and germ cells, and a few years later he concluded further that, inasmuch as tumor cells are merely ordinary somatic cells living under special conditions, the proof had been supplied, as far as that can be done, that ordinary somatic cells are potentially immortal. He also pointed out that this conclusion could be still further confirmed by serial transplantations of ordinary tissues in animals of various ages. He began such experiments a number of years ago and is continuing this work now under more favorable conditions.

Experimental tumor investigation has furthermore demonstrated that many somatic cells have a potential power to proliferate which appeared almost unthinkable until recent years, one single epithelial or connective tissue cell being potentially able to produce masses of cells which surpass many times the number of cells composing a whole animal of the same species.

Investigations by M. S. Fleisher, in Dr. Loeb's laboratory, fail to show the definite rhythmic changes attributed to tumors by Bashford and Calkins, and Dr. Loeb thinks that if they exist in the case of other somatic tissues, they are not primary attributes of these tissues, but due to secondary mechanisms.

Professor Nipher stated to the Academy that he had recently obtained results confirming his previous conclusion that the strength of a steel magnet depends upon its electric potential.

G. O. James,
Corresponding Secretary

The Anthropological Society of Washington

The 467th regular meeting of the Anthropological Society of Washington was held in room 43 of the new building of the National Museum at 4:30 P.M., March 18, 1913, the president, Mr. Stetson, in the chair. Dr. John R. Swanton read a paper on "The Creek Confederacy."

After explaining the geographical and linguistic positions of the tribes of the Creek confederacy with the assistance of a map, Dr. Swanton traced the evolution of the confederation from a small nucleus of tribes speaking the Muskogee language to a large association, comprising a number of Hitchiti speaking people, the Alabama, Koasati, some of the Apalachee and Yamasi, part of the Natchez, the Yuchi, and, for a time, some of the Shawnee. He showed that this association was facilitated through the institution of a dual division of towns into white or peace towns and red or war towns, the towns of each division, or "fire," considering each other friends or allies, and having opposing but not warlike relations with the towns of the other "fire." It thus happened that when an outside town or tribe came to be accepted as a "friend" of one of the white or red towns in the confederacy its position with reference to all of the other white and red towns was thus established and it entered into the confederate scheme. The communication of other common features to the new towns also took place, although more slowly. Such features were the "green corn dance" or busk, or perhaps rather the Muskogee form of it, participation in common although irregular councils, and the adoption of Muskogee as the standard language of intercommunication. The actual discontinuance of the proper languages of the various members of the confederacy was, fortunately for the ethnologist, much slower, several of them having persisted down to the present day. Through the progressive adoption of smaller tribes and the practical destruction of some in warfare, a process accelerated by white contact, the Creek confederacy came to be almost the sole representative of eastern Muskhogean culture, and even influenced the culture of the Chickasaw to a marked degree. The great Choctaw body, on the other hand, maintained its cultural independence and was never dominated by the Creeks. In sharp contrast to the Creeks, whose national structure was built up by fitting numerous distantly related tribes into an artificial fraternal scheme, the Choctaw seem to have owed their sense of unity to an actual homogeneity in the Choctaw population, the occupancy of a common area, and the necessity to resist common enemies. They perhaps preserved the simplicity of culture existing among all Muskhogean Indians in times long anterior to the formation of more complicated associations or confederacies.

There was no discussion.

Wm. H. Babcock,
Secretary